THE ROYAL SOCIETY
FOR THE PROMOTION
OF HEALTH
90, BUCKINGHAM PALACE ROAD, LONDON, S.W.1

Borrowers must comply with the following by-laws governing the Library, made by the Council of the Society.

Books, periodicals and pamphlets may be borrowed by Honorary Fellows, Fellows, Members, Licentiate Members, Associate Members and Affiliates personally or by a messenger producing a written order. The person to whom such publications are delivered shall sign a receipt for them in a book provided for that purpose.

Publications may be borrowed through the post, or by other means of carriage, upon a written order. The postage, or carriage of publications returned to the Society shall be defrayed by the borrower.

A borrower may not have more than three publications in his possession at one time.

A borrower will be considered liable for the value of any publication lost or damaged while on loan to him, and, if it be a single volume or part of a set, for the value of the whole work thereby rendered imperfect. Marking or writing in the publications is not permitted, and borrowers are requested to call attention to damage of this character.

Books and pamphlets may be retained for twenty-eight days. Periodicals may be retained for fourteen days. Applications for extension of the loan period must be made in writing before its expiry. No publication may be kept longer than three months.

Books and pamphlets added to the library will not be lent until after the expiry of one month from the date received. The current number of a periodical may not be borrowed.

Borrowers retaining publications longer than the time specified, and neglecting to return them when demanded, forfeit the right to borrow until they be returned, and for such further time as may be ordered by the Council.

Any borrower failing to comply with a request for the return of a publication shall be considered liable for the cost of replacing it, and the Council may, after giving due notice to him, order it to be replaced at his expense.

No publication may be reissued to the same borrower until at least seven days have elapsed after its return, neither may it be transferred by one borrower to another.

Publications may not be taken or sent out of the United Kingdom.

Publications returned through the post must be securely packed and adequately protected.

The library may be used for reference by members during the office hours of the Society.

Publications borrowed through the post must be acknowledged on the form provided, immediately upon receipt, and returned when due to the Librarian at the above address.

O.B., Truro.

APPERTIZING

OR

The Art of Canning; Its History and Development

BY

A. W. BITTING, M.D.

Formerly Food Technologist, Bureau of Chemistry; Food Technologist, Research Laboratory, National Canners Association; Executive Officer, Planning Branch, Quartermaster Department (during the War); Director of Research, Glass Container Association.

THE TRADE PRESSROOM
SAN FRANCISCO, CALIFORNIA
1937
A new method for conserving foods for a long time was announced in 1810 by Monsieur Nicolas Appert, a Frenchman, who found through experiments that food substances placed in tight containers, hermetically sealed, and subjected to a due amount of heat would keep. This simple discovery was accompanied by an admonition emphasizing the use of only strictly fresh, sound materials, to observe celerity and scrupulous cleanliness in the preparation, and also to exercise the utmost care in closing the container and in the application of heat.

Though a few persons had the imagination to visualize some of the benefits which it was hoped might be realized, the full import of this discovery could not be grasped at the time. It remains for us a century and a quarter later to more nearly appraise its value in the light of the salutary effects upon health resulting through the making better and safer foods available at all times and places, in eliminating drudgery and the time consumed in food preparation in the kitchen, and by adding to the pleasures of the table. The enormous annual production of all kinds of canned foods is its own commentary upon its worth to industry. Appert’s accomplishment deserves to rank among the outstanding achievements of all time and the author for what he was—"A Benefactor of Humanity."

Back of this masterpiece in food conservation were forty years of rich experience in almost every phase of food preparation and fifteen years of patient painstaking research conducted with such limited funds and equipment as to discourage an ordinary man, but so methodical and thorough was his work that he was able to give full directions for conserving most fruits, vegetables, meats, and soups. The results were based on many trials as scientific in conception and execution as if carried out in the best laboratories. He was unable to explain why his products kept other than that he believed the combination of heat and the exclusion of air averted the tendency to decomposition. Science could render him little aid since chemistry was only in its beginnings and bacteriology was unknown. It remained for Pasteur, a half century later, to supply the explanation, and after a lapse of another third of a century for Russell, Prescott and Underwood, and Macphail, independently and almost simultaneously to apply the new science to the industry.

The present canning practices are the result of evolution from the older methods gained from experience, the application of the sciences of physics, chemistry, biology, and bacteriology to the problems of food preparation and sterilization, plus engineering skill in developing systems and equipment to handle products in small or large quantities quickly, with the minimum of labor and under strictly sanitary conditions from the raw state to the finished package in the kitchen storeroom or in the warehouse.

It is the object of this work to present the more important facts in the history and development of this branch of the food conserving industry
with the hope that it may afford a better background and understanding of the methods now in use, make available some of the fundamental investigations not readily accessible to those engaged in research, and by presenting the facts concerning several lines of canning in different places enable superintendents to modify some of their practices or adapt steps from other lines to their advantage. How important this may be can be judged from the fact that in 1910 there were not more than four or five persons offering their services as food consultants to the industry. Now it is believed that there are more than three hundred companies employing trained scientists in the control of their products.

Many patents have been quoted in whole or in part as they generally reflect the most advanced thought when they were taken out, and this has been done irrespective of whether the method proposed or devices suggested would be approved at the present time. The sterilizing cook generally recommended is treated in a like manner as is also the fill of the container and the weight recommended for declaration upon the label. It will be obvious to some that the slide rule or other mathematical calculator has supplanted the chef in some lines and that to the detriment of the products and the application of plain common sense.

The canning industry is entering a new era of standardization and regulation. Thirty years ago everything was individualistic, each packer operated according to his own knowledge and experience. During this short interval an almost unbelievable number of laws, rules, and regulations of one kind or another have come into force, the vanguard of a host sure to follow. These are incorporated for the guidance of those operating at the present and as a record of the simple life of the canner in 1937.
L'ART DE CONSERVER,
PENDANT PLUSIEURS ANNÉES,
TOUTES LES SUBSTANCES ANIMALES ET VÉGÉTALES;

OUVRAGE soumis au Bureau consultatif des Arts et Manufactures, revêtu de son approbation, et publié sur l'invitation de S. Exc. le Ministre de l'Intérieur.

PAR APPERT,

Propriétaire à Massy, département de Seine et Oise, ancien Confiseur et Distillateur, Élève de la bouche de la Maison ducale de Christian IV.

« J'ai pensé que votre découverte méritait un témoignage particulier de la bienveillance du Gouvernement. »

Lettre de S. Exc. le Ministre de l'Intérieur.

A PARIS,
CHEZ PATRIS ET Cie, IMPRIMEURS-LIBRAIRES, QUIAT Napoléon, AU COIN DE LA RUE DE LA COLOMBE, N° 4.

1810.

FACSIMILE OF THE FIRST TITLE PAGE
Nicolas Appert, who developed the present method of food preservation by heat in a hermetically sealed container, and whose accomplishments were so successful and far-reaching that they have contributed in a marked degree to the present improved living conditions, was until recently practically unknown to the great mass of his beneficiaries, though the principles he enunciated and the processes he developed a century and a quarter past are used both freely and extensively. He was the creator of a great industry which should bear his name.

To the scientists of his time whose work was along allied lines, he was known and respected for his achievements and for his rare and sterling character. These are attested by the testimonials of the foremost men of the period—Bardel, Gav-Lussac, Parmentier, Corbiere, and others, also by the never to be forgotten Careme—and undoubtedly greatest praise of all, his work was copied frequently but without credit as to source.

In spite of all this and the many editions of his book on the preservation of food covering nearly a half century, interest in this form of food preservation made slow progress; then came a renascence as the possibilities were appreciated. But the renascence, however, extended only to the material gain to be derived, apparently not including remembrance nor gratitude to the inventor. How many of the vast number of commercial preservers or other interested persons throughout the world know of the man who made their work possible through his almost superhuman persistence in the face of personal privations and losses? To some of these Nicolas Appert is known only as a Frenchman who received an award from his government for his work upon conserving foods, but, beyond this, little else. The kind of man he was, his training, the spirit in which he did his work, his difficulties, his achievements, and the recognition he received beyond the government award, are not known. Yet his life is inspiring, for his service was world-wide in its influence and benefits. The record he has left shows him to have been of a kindly generous spirit, possessed of a keen intellect, and indomitable courage and perseverance in the face of difficulties, coupled with a desire to benefit humanity so far as possible with his limited means.

Recently a wave of sentiment swept the discerning world in recognition of the debt of gratitude owed to the great scientist, Louis Pasteur, for his humanitarian work, and yet for genuine accomplishment the work of Nicolas Appert, which preceded, deserves at least like credit. The elimination of scurvy, the substitution of appetizing food for the all-prevalent salted meats and hardtack of the navy and the precarious foods of the army, and above all, the making possible greater variety of safe, wholesome foods for all classes of people, mark one of the distinct advances in civilization.
Pasteur’s work, great as it was, was facilitated by the earlier work of Appert in the preservation of liquids and foods by heat as he attested,* but to these Pasteur added the correct explanation of preservation and the means of scientifically determining the treatment required.

Nicolas Appert was born in 1750, at Chalons-sur-Marne, and lived in moderate circumstances, acquiring an education through personal effort. He worked and experimented with foods all his life; conducted and superintended the operations in making confectionery, in distilling, in stores-houses for grocers, in kitchens, and in the wine cellars of Champagne, so that, in 1795, when the French government offered a prize for an improved method of conserving food, he naturally gave it attention. France was suffering acutely for lack of certain kinds of foods and through unsuitable preparation of others. Scurvy took a tremendous toll in the navy, while malnutrition and dietary diseases were rife in the civilian population as well as in the army. The conditions were only slightly different from those in other European countries but in France apparently were discerned earlier and the remedy sought. It was while endeavoring to assist the government that Appert developed his method of preserving foods by heating in closed containers, and to which he gave unremitting effort until his death in 1841.

This obscure French citizen was a rare scientist, he was able to plan experiments methodically, to verify by exact observation, to formulate and arrange systematically, and to draw logical conclusions. He observed in his experience and in that of others that occasionally food heated in a closed vessel remained stable indefinitely. He reasoned that if some food kept under the conditions, other foods ought to also, if only the conditions incident to them were known likewise. He denied there was such a thing as chance. Since he could not summon the sciences, as understood today, to his aid, as bacteriology was unknown and chemistry just emerging from the shadow of alchemy, experiment was the only means available to him, so he set himself the task of preserving various foods under the conditions noted. The difficulties he encountered can be appreciated somewhat when it is considered that there was an almost universal belief in spontaneous generation, there was slight conception of sterilization, nor how it could be produced. Hermetically closed containers were unknown, dependence being on more or less imperfect corks, bladder, parchment paper, and such domestic expedients as layers of fat, etc. He had not only to grope blindly as to the time and temperature required in the heating of the foods, but to design the containers, in this case bottles, and to make the corks to close them.

In his book is a description of his laboratory and its equipment, meager and crude when compared to those of the present day of spacious buildings, with elaborate and costly apparatus made possible by the state, individual donations of public spirited citizens, or the combined efforts of concerned

---

* "This is the method that Appert has previously put in practise with so much success for the conservation of a multitude of alimentary substances, method the germ of which is likewise found in the experiments of Needham and Spallanzani on the subject of the generations called 'spontaneous' as I have remarked elsewhere.

"When I published the first results of my experiments on the possible conservation of wine by preliminary heating, it was evident that I only made a new application of the method of Appert, but I was absolutely ignorant that Appert had devised this same application a long time before me."* Pasteur, L. Etudes sur le Vin, 2d ed. 1873. Pp. 133-134.
associations. He had a compartment for marmites or kettles for the preparation of meats, soup, milk, fruit juices, etc.; another for corking, wiring, and putting the bottles in sacks for the cooking; and a third for the heating of the kettles, which were set in masonry, from which the fire was withdrawn when the heating was deemed sufficient. As the work progressed and larger kettles were used, valves were placed in the bottom to draw off the hot water, so as not to subject the food to too long heating. Appert states that the small water-baths were more convenient, as they could be placed anywhere and cooled more promptly, the bottles being removed when the operator could hold his hand in the bath.

Bottles were used as they were “most impermeable to air,” but as the ordinary ones had openings too small and were otherwise too weak to resist the treatment in corking and heating, he had special bottles made, some having openings of more than four inches. He made the stoppers from 3, 4, and 5 layers of selected cork, with the pores running horizontally so as to hinder access of air. Though cork tissue is only slightly permeable to water, through defects in the development of even the best cork, there are present other forms of cells which cause fine pores in the layers and these permit slow entrance of air, and consequent possible contamination. The method which Appert used in the manufacture of stoppers shows his appreciation of the conditions in the extreme thoroughness he used in this as he did in all phases of his work. The bottles were put into sacks for protection, and also for ease in removing any broken as a result of the heating.

In spite of all the handicaps that these preparations entailed, he made such progress that a public record sent to the marine prefect at Brest by the Board of Health, in 1804, is as follows: “The provisions prepared according to the process of Citizen Appert, and sent to this port by the Minister of Marine, have, after a sojourn of three months on the roadstead, presented the following conditions:

“The broth in bottles was good; the broth included with boiled beef, in a special vessel, good also but weak; the beef itself very edible.

“The beans and green peas, prepared both with and without meat, have all the freshness and the agreeable savour of freshly picked vegetables.”

This was signed by the five members of the committee.

Grimod de la Reyniere, a fluent and sparkling writer on gastronomy, who with equal facility could eulogize or caustically criticise and in consequence was both respected and dreaded, in his Almanach des Gourmands (Vol. 3, 1805), states that M. Appert had such success “that in each bottle and at slight cost is a bounteous entremet that recalls the month of May in the heart of winter, and often even deceives, when it is dressed by a skilful cook; it is not an exaggeration to say that the small peas particularly, thus prepared, in short are as green, as tender, as savory, as those that are eaten in season.” He also stated that M. Appert had bought land at Massy, near Paris, where the fruits and vegetables were grown, and where workrooms were established in order that the operations might be carried on without delay and before any deterioration in quality could take place.

Another eulogistic commentary on the work was made in the Courier de l’Europe (Feb. 10, 1809) wherein was stated: “M. Appert has discovered the art of fixing the seasons. With him spring, summer and autumn exist
in bottles like delicate plants that are protected by the gardener under a dome of glass against the intemperance of the seasons."

The results of his experiments were so remarkable that many persons could not believe that heat was the only agent used in their conservation. The members of the Society for the Encouragement of National Industry were so impressed with the results that they brought them to the attention of the government, and in 1806 some of the preserved foods were shipped on government vessels in order to subject them to more comprehensive tests. The foods were carried across the equator and far south, so as to subject them to extremes of temperature and the varying conditions of humidity and transportation. As a result, the ships’ captains and the maritime prefects at shipping ports made most favorable reports, in which they called attention to the possibility of provisioning the navy with foods which, by replacing the salt meats, would prevent the ravages of scurvy, the greatest scourge of the sea-faring. Following the tests and the rigid examination of the foods, the statement was made: “The Society for Encouragement believes it will be serving the country and humanity, by publishing, with the eulogies that it merits, a discovery so generally useful.”

During the time Appert was conducting his experiments the French government was making strenuous efforts to promote agriculture and the industries so as to lessen the consumption of foreign goods, which was largely due to the Napoleonic wars. The Society for the Encouragement of National Industry announced awards for discoveries, and the Society of Agriculture made an appeal for information upon the preservation of foods.

The Minister of the Interior requested the Consulting Bureau of Arts and Manufactures to make an investigation of the processes and products, and on the recommendation of the committee from the Bureau, an award of 12,000 francs was made to Appert. In notifying him of the award the minister said: “It has appeared to me, Sir, that it is of moment to spread the knowledge of your processes for the conservation of animal and vegetable substances. I desire, then, that conforming to the proposition that you have made that you write an exact and detailed description of these processes, this description that you deposit with the Consulting Bureau of Arts and Manufactures, to be printed at your expense, after it has been examined and reviewed. You are then to send two hundred copies of it to me. The delivery of these copies being the only condition that I require for the payment of the 12,000 francs that have been awarded to you. I have no doubt that you will hasten its fulfilment.”

The description which was published in June, 1810, was called Le Livre de tous les menages, ou l'art de conserver, pendant plusieurs annes, toutes les substances animales et vegetales.

This had a second edition in 1811, a third in 1813, a fourth in 1831, these three revised and augmented by Appert himself, the last when he was 81 years old, a fifth in 1842 after his death revised by his nephew Prieur Appert and M. Gannal. Two other French editions, 1857 and 1858, besides numerous extracts from the work in various journals have been published. Many translations were made into other languages, among them and evidently the earliest was one in German by the chief pharmacist of the Coblenz general hospital, who sent a copy to the French Minister of
the Interior in October of the year that the original appeared. Another German edition, 1822; Swedish, 1811; English, 1811, a second edition, 1812; American, 1812 from the 2d English edition; one in 1920 of the 1st French edition, and in 1921 of the 4th edition, both by the writer, who at the time had only these two editions. There may be and likely are other early translations for the results were so far-reaching and at the time the need was urgent.

Many claims have been made as to the priority of other nationals in the preservation of foods by means of heat in hermetically sealed containers, and also that the theory was known before the time of Appert. The evidence proves, however, that Appert was the first person to apply the principle to the preservation of foods in general and on a commercial basis. He states in a discussion of his work: "Not to my knowledge has any author, ancient or modern, indicated, nor even surmised, the principle that forms the basis of the method which I offer." He states further: "I owe to my experiments, and above all to a great perseverance, to being convinced, first, that the subject of heat has the essential quality in itself not only of changing the combination of the constituent parts of animal and vegetable products, but also that, if not destroying, at least of arresting for many years the natural tendency of these same products to decomposition; second, that its application in a proper manner to all these products, after having deprived them in the most rigorous manner possible of contact with the air, effects perfect preservation of these same products with all their natural qualities."

This exposition, most remarkable for the period, is more nearly according to the principles and conditions as we understand them today and also indicates clearer insight than that of the chemist Gay-Lussac, who was one of the committee to verify Appert's experiments. Gay-Lussac, in a memoir to the Institute, December 3, 1810, said: "Vegetable or animal substances, through their contact with air, acquire immediately a disposition to putrefaction or fermentation; but in exposing them to the temperature of boiling water in vessels well closed, the absorbed oxygen produces a new combination, which is no longer able to excite fermentation or putrefaction, when it becomes concrete by heat in the same way as albumen."

In judging any work of that period it must be taken into consideration that there was no knowledge of bacteria at the time, and that the only works that had a direct bearing on the subject were those of Needham, Spallanzani, and Scheele. Needham, an Englishman, published a paper in 1745 in which he gave supposed proof of spontaneous generation. The "proof" consisted in boiling meat extract, then closing the flask air tight, after which it was left for several days. When the flask was opened, the extract was swarming with "infusoria," and as the author was positive the heat had destroyed the "eggs" present in the extract and had precluded any entrance from outside, those present must have originated spontaneously. In 1765, Spallanzani, an Italian, claimed that in Needham's work there must have been entrance of air not subjected to heat, otherwise there would be no life present, as his own experiments had demonstrated. Unfortunately, his experiments were attended with a number of failures sufficient to throw doubt upon his conclusions, consequently they were not generally accepted. These germs of the principle of sterilization were not extended
to any practical application except in the most meager way by Scheele, a Swedish chemist, who in 1782, advocated the conservation of vinegar by heating it in a well-tinned marmite and boiling on a quick fire for a quarter of a minute, then filling into bottles and covering with a layer of oil, or if the tinning was feared as dangerous to health, the vinegar could be put into the bottles, these put into a kettle of water, and, when the water had boiled an instant, the bottles removed.

Though the correct principle was used by Scheele, his work did not add to an appreciable extent to the practical conservation of foods, and in fact, was preceded more than a century by the work of some unknown and ignored author, who in his (or her) book (A Book of Receipts According to the Newest Method, 1680, p. 42) has given directions for conserving fruit, even to the most recent oven cooking advocated by the instructors of home canning, but this lacked the prestige of the scientific atmosphere so received no more attention than the usual cookery book.

"To keep Gooseberries, Damsons, or Bullies.

"Gather Gooseberries at their full Growth, but not ripe, Top and Tail them, and put them into Glass Bottles, put Corks on them but not too close, then set them on a gentle Fire, in a Kettle of cold Water up to the Neck, but wet not the Cork, let them stand till they turn White, or begin to Crack, and set them till cold, then beat in the Corks hard, and Pitch them over.

"You may do them in an Oven if you please, or cork them down hard, and pitch them over, and they will keep without scalding."

It is doubtful that Appert had cognizance of the work of Scheele, and, though he had, it would not deprive him of the honor due him, for he not only conserved all kinds of food, but in addition conserved them in such a way that they retained their edible qualities. This same lack of knowledge of the work of others is indicated, as previously stated, in the statement by Pasteur, who also was not cognizant of the amount of practical work done in England and America following the publication and translation of Appert's book in 1810.

The English claimed that one of their countrymen, Donkin, had preserved foods by means of heat prior to Appert, though Donkin acknowledged (Repertoire des arts et de l'agriculture, No. 112, mois de septembre) that he owed the knowledge of his process to a person resident of a foreign country, and, while Appert was not named, he was clearly designated through public evidence and the priority of his processes. In 1807, three years after the public tests were made on Appert's products at Brest, Thomas Saddington, an Englishman, was awarded a premium by the London Society of Arts for a method of preserving fruits "without sugar for house or sea stores." Saddington had travelled abroad and acknowledged that he owed his knowledge of preserving to what he had learned there. The premium seems to have been all that resulted from Saddington's work, for after the publication of Appert's book, in 1810, the English used it unreservedly as a textbook, the extent being indicated by the short time intervening between the first and second editions of the English translation. No other publication of consequence along similar lines appeared for over seventy-five years nor was science applied to the study of the processes until eighty-five years from the first publication, though in the meantime millions of cans had been successfully packed and consumed.

Though Appert had a workshop, the place was not only meager, as indicated, but also run down, as he spent on experiments the money made on
the sale of his products. The award from the government, however, enabled him to purchase needed equipment and to establish on a commercial basis the "House of Appert." The establishment dates officially from 1812, and has been in continuous operation since by the same family. At the time of the founding of the factory Appert was 62 years old, and, judging from his later work, must have pursued his experiments with unabated enthusiasm and energy.

The magnitude of his achievement can be appreciated only when it is understood that to the designing and manufacture of the containers, were added the large and varied number of products that he conserved. In the first edition of his book directions are given for packing meats, soups, milk, eggs, vegetables, fruits, kitchen and medicinal plants, essences, fruit juices, etc., and directions how to prepare them for serving. He understood so well the conditions that he changed his process according to the variations in maturity of the product, and also for the change in climatic conditions in dry and wet seasons. In his directions for the proper cleaning of utensils and the preliminary preparation of apparatus and materials, he says: "It is not necessary to recommend celerity and the strictest cleanliness in the preparation of foods; they are indispensable, particularly for those that are to be preserved."

In 1814 he delivered all the products requested by the government, "fresh meats, game, consomme, milk, fish, lobster, pates of meat and fowl, fresh eggs, cream, butter, vegetables, fruits, and anti-scorbutic juices." In 1824 he presented the juices of meats and of vegetables in tabloid form to the Society for the Encouragement of National Industry. From 1809 to 1830 the bulletins of this society contain accounts of his work with eulogistic reports. In 1816 he was awarded a silver medal, in 1820 a gold medal, and in 1824 a prize of 2,000 francs, offered in 1820 to whomsoever would preserve 8 to 10 kilograms of animal substance in the same vessel for one year, and so justify an investment of 20,000 francs. The offer had been made to encourage manufacturing on a wholesale scale thus avoiding the large number of small containers, which were an encumbrance on ships. The conditions were that during the intervening time the products were to be carried across the equator, some opened on board while crossing or at the landing port, the others to be brought back and sent to the Society to be opened after verification of the seal affixed by the authorities at the port of embarkation. The competitors were to show by their records that they had manufactured and sold 20,000 francs worth each year. There was only one competitor besides Appert, but he had not fulfilled the conditions for the time the foods were preserved nor for the amount of sales. One of Appert's containers held 17 kilos, the product of nearly 30 kilos of beef which had had the bones removed; another container held spiced beef and poultry jelly reduced to the consistency of a thick syrup; these were preserved for two years, while his factory records showed that he had sold similar products to the value of more than 100,000 francs a year.

In 1814, Appert went to London to demonstrate his methods, expecting to bring back a large order for his goods, but in this he was disappointed, for all that he received was a certificate laudatory of his work and later the flattery of imitation. The English were better equipped to utilize the discoveries than was Appert, and seeing the possibilities in the invention,
organized a company, and designed tin containers to replace the glass bottles used by Appert. But they seem to have been better versed in organization than in the process, for in less than three years they lost 100,000 francs in their efforts to preserve food. The advantages, however, appeared so great that the loss did not deter them from continuing the work until success was attained.

Later Appert used tin cans, but as the French at that time were poor artisans in this metal, he was obliged to make the cans in his own factory. The tinplate was of poor quality, being defective in ductility and in other respects, and the cans, when emptied, could not be used for other purposes, so, to avoid the bulky accumulation on board ships, were thrown overboard. To remedy this condition Appert used wrought iron that he tinplated after the can was formed. These cans were made to have a capacity of four to forty-five pounds, and could be used many times; by adding handles they could be used as casseroles. The reworking of the cans was done by the sailors in slack times on long voyages. The cans were made of very ductile plates of sheet iron with the seams brazed and proved entirely satisfactory. On account of the disadvantages of the tinplate, the Society for the Encouragement of National Industry came to the rescue and offered a prize to anyone who would make vessels of plated wrought iron or any other metal or alloy as harmless to health as iron.

Appert was prevailed on by the seamen to make square cans in order to stow them to better advantage but they proved unsatisfactory as extra care and expense were required in both their manufacture and closure; besides, on cooling, they became depressed on six surfaces instead of top and bottom as in the round ones. He advocated round ones except for foods such as fowl, etc., for which oval cans were better adapted. It is noted that Appert made and used the three forms of cans—round, oval, and rectangular—that are in present usage.

The fourth edition of his book, which is greatly enlarged over the first, contains four large plates showing the arrangement of the apparatus, including autoclaves for cooking under pressure, apparatus for the concentration of liquids, turnspits for the preliminary roasting of meat and fowl, etc. Directions are also given for the preservation of fine wines, wines so delicate that they were injured by a short sea voyage, and some could not even stand storage. These were heated carefully at comparatively low temperatures, some shipped to San Domingo, and after two years returned and examined. Check bottles of the wine had been held without heating, to compare the unheated and the transported wines. The treated wine was found to be of good quality and satisfactory in all respects, whereas, that held untreated had deteriorated, having developed a disagreeable taste. Similar experiments were made with beer with equally satisfactory results, but the only explanation he was able to make was that the "principle of fermentation" was destroyed.

A method of treating milk to temporarily preserve it so that it might be sent to a city market is given as follows: "A proprietor from the neighborhood of Gournay, who came to consult me, asked me to indicate a way of holding his milk for two days, the time necessary to transport it to Rouen, that is to say, a distance of twenty leagues (50 miles). This is the process I indicated to him, and which he practiced with the greatest success:
"I made some tin cans of the form and opening of ordinary bottles, filled them with warm milk just from the cow, and after properly corking and wiring put them in the water-bath, which was brought just to boiling. After an hour I took them out, and the following day I forwarded them to a distance of thirty leagues (75 miles), where they arrived forty-eight hours after. The milk was found to be very good and perfectly preserved. Since this test the proprietor sends his milk every day to Rouen to be sold; he even forwarded some to me in Paris, which one could believe had been milked the day before.

"The application of this process on a large scale offers some very great advantages; it would permit manufacturing in all the large cities, even in Paris, the fresh butter that is consumed there, and which rarely arrives in good condition; it should also occasion a great diminution in the price of this commodity of prime necessity. The farmers should likewise find profit from it, in utilizing by this means all their cream, lost in large part through the impossibility of holding it long enough to accumulate the quantity necessary to make butter, whereas, by preserving it in the way indicated, and being able to send it long distances, they are always assured of a market."

This method of heating, devised by Appert, is one used at the present time for milk and other liquids, modified only in minor details to suit the character of the particular liquid and strangely is known as pasteurization, having been named for Pasteur, who improved the technique by using exact temperatures for definite periods in his work on checking diseases in wine and beer. Appert likewise devised a method for the extraction of gelatine from bones without the use of acid, also prepared neatsfoot oil, manufactured bouillon tablets, and devised a method for the melting and clarification of suet for use in candles, etc., to be done in such manner that the factory was not a nuisance to the neighborhood. In this work he used an autoclave, which at that time was regarded with fear, due to the accidents which occurred in its use.

The autoclave was in reality an enlarged Papin digester, the original being a small apparatus in which to cook foods under pressure and so shorten the time. From lack of regulation of both the fire and the resulting steam pressure, accidents attended its use, so it came to be regarded as an infernal machine to be avoided. Some discerning persons sensed the value of its application, but through fear of its effects, the experiments in which it was used were vitiated. Modifications of it had been made but were not improvements on the original, each one in turn being abandoned. One of them that approached more nearly to the original was used by Appert, and in consequence it was predicted that not only he and his factory, but the entire neighborhood would be blown up, as a similar apparatus had exploded and blown the head off an enthusiastic but too impulsive user. It is characteristic of the manner in which Appert worked that, instead of abandoning the autoclave, he analyzed the cause of the accident, made improvements on his own, and had two others made of greater capacity capable of withstanding higher pressures, and did the actual handling of the three himself, because even the trained workers were intimidated by the escaping steam. When it is realized that there was no known method to regulate the heat other than by the withdrawal of the fire from beneath the
apparatus, or judging of the degree of heat except by the more or less rapid evaporation of a drop of water thrown on the cover, the danger from its use was not greatly exaggerated. Appert estimated the heat from the amount of charcoal burned, combined with a close surveillance of the weights placed on the valve as the steam increased in volume.

In the same edition are also directions for preparing many new foods, both animal and vegetable. The list of products is large and varied, each having its appropriate seasoning and sauce with directions for treatment when taken from the container. The foods listed would reflect credit on present day products.

Appert worked in his factory nearly to the time of his death, which occurred in 1841, leaving a record for inventive ability, marvelous perseverance, and a comprehensive knowledge of foods. He was exceptionally modest and of a generous spirit. Frequently he states that he makes no presumptuous pretensions to explain scientifically why certain effects resulted from his experiments, though "the results are always subordinate to the intelligence, the celerity, and the knowledge of the manipulator." Instead of magnifying the importance of his work and the indispensability of a laboratory and special apparatus, he states that in the home a special workroom is not necessary and that "the vessels and other utensils that are found wherever economical housekeepers are occupied with their winter provisions, suffice for working according to my directions." He had no toleration for those who attributed the results to chance, since "nature obeys constant laws," and poked fun at the person who was on the lookout for secret processes. In a description of the behavior of some bottles in a water-bath, he tells of the heavy bottoms separating in such manner that they could not have been cut with greater precision. One day as a joke he took twenty-four of these, reversed them, put two whole artichokes into each one, replaced the bottoms, luted them carefully, then as the bottles were corked and wired, put them neck down in the water-bath, keeping the luted bottom above the water. The operation was successful, the lute being so identified with the glass as to be imperceptible. Appert amused himself by showing them to the curious who visited the factory. One visitor became very insistent to learn how the artichokes had been introduced through such a narrow neck, and Appert responded that the method was his secret. Then the visitor wished to know how they were to be taken out. "Faith, Sir, discover it and you will know as much as I," responded Appert. "Is it necessary to break the bottles?" persisted the bore. "It is as good a way as any other," was the response as Appert escaped, laughing at such simplicity.

As Appert made new discoveries, additions, and improvements to his equipment, he published full and detailed accounts of these in the various editions of his work as well as communications to the Society for the Encouragement of National Industry, as he wished all to benefit from his results, though the returns from his sales lagged behind the cost of his research, keeping him in straitened circumstances. This generous procedure caused him to have many imitators in time, but did not make him bitter. On one occasion when told of the publication of a similar book* to

his, and of which it had been the inspiration, he said: "Now the housekeepers will have two to depend on instead of one."

His genius in research coupled with the generous spirit caused the Society for the Encouragement of National Industry to bestow on him, in 1822, the title "Un Bienfaiteur de l'Humanite," which he richly deserved, for he could have become wealthy by reserving his discoveries to his own advantage, as other countries as well as France undoubtedly would have paid well for a knowledge of the discoveries which he gave so freely. They have enabled countless millions to be made since, both in canning and in supplies and machinery, many of those profiting not even knowing the name nor giving a thought to the discoverer. Not all shared in this indifference. As the Germans were the first outside of his own people to appreciate and acknowledge the value of Appert's work, so when the 1920 American translation appeared, it was Mr. Chas. Ams who wrote to the translator stating that if a memorial should be made in this country by those most directly benefiting from Appert's work, he wished to contribute.

Appert's modesty in disclaiming all pretentions to scientific attainment, though his work is of the highest scientific character, has caused him to suffer neglect in not always being listed with the scientists of his time. This goes so far that there is even doubt in some quarters as to his given name, which is due in part to the French custom of that period of merely giving the surname. He is sometimes called Francois, but the writer was supplied by M. Chevallier-Appert with a copy of his ancestor's birth certificate from the register of the City of Chalons-sur-Marne and is as follows:

Extrait des Registres de l'Etat-Civil de la Ville de Chalons-sur-Marne (Paroisse Saint Loup).

Naissance de Appert, Nicolas. 23 Octobre 1752.
Nicolas, fils de Jean Appert, peigneur de laines, et de Marie Bonvallet sa femme de la paroisse Saint-Loup, est né le vingt-trois Octobre mil sept cent cinquante-deux et le même jour, a été baptisé, son parrain Nicolas Moret, sa marraine, Marguerite Duchez qui ont déclaré ne savoir signer. Signé Robin vicaire de Saint-Loup.
Pour copie conforme. signe; le Maire de Chalons.

For several years before his death, Appert had his nephew, Prieur Appert, associated with him, and it was he who conducted the business until 1846 when Raymond Chevallier-Appert came into possession. The latter was a worthy successor of Nicolas Appert, as he carried on the high traditions of the house for experimental work, and in patterning after the founder, he deposited in 1852, with the Society, an entire sheep that had been prepared more than a year previously. In the same year he received a patent for an autoclave with a special gauge for registering the pressure, so that he brought the Papin digester, improved and made safe, to a happy fulfillment and made possible its use in laboratories and factories throughout the world. He also perfected and added to the number and quality of the products and brought the house to a high state of prosperity.

Raymond Chevallier-Appert was succeeded by his son Alfred, who had been collaborator for many years, and who directed the house, now known as the "House of Chevallier-Appert," for forty years. In 1896 he was made Knight of the Legion of Honor for the services he had rendered to the industry in improving the processes of manufacture. He elaborated a new process for meat for the army, called the "Chevallier-Appert Process," and this is prescribed by the regulations of the Military Subsistence Ser-
vice, no meats being accepted for France, or its colonies that are not prepared according to this process. That it is successful is attested by the fact that during a campaign the soldiers eat the meat willingly and without waste, a novel experience in army foods. Alfred Chevallier-Appert was a courteous, affable gentleman, beloved by his associates. He died in 1909, leaving a most creditable record for high principles and efficiency.

For many years Alfred Chevallier-Appert had his son Raymond associated with him, who became successively a director, associate, and on the death of his father, head of the house. His record is a succession of honors from private associations as well as from the government. He was made Knight of the Legion of Honor in 1912, and for his active and honorable work during the World War was advanced to Officer of the Legion of Honor in 1923. The presentation made the occasion of the most cordial manifestations of regard by both his colleagues and government officials. Particular stress was laid on the fact that in the early days of the war, during monetary disorder, attempts were made to loan money to the government at a high rate, and before competition could be secured, Raymond Chevallier-Appert declared at once to accept less compensation, and added to this, the provisions that he furnished to the army were the best that could be produced and not like some other manufacturers who took advantage of the public misfortune to enrich themselves by sending products to the army that were edible only in name. In the laudations it was emphasized that he upheld the fine traditions of his predecessors who had set high standards in their work, and had created an institution of which France might be proud.

The progress of the House of Appert has been recognized in the various countries in which public expositions have been held by the bestowal of the highest awards for the excellence of their products, beginning in 1809 in France and extending to 1915 in the United States, the list makes a continuous and imposing array of honors.

As French cooking is undoubtedly of the highest world standard, including the elaborate and expensive, as well as the simple and inexpensive, though attractive dishes, the products of the House of Chevallier-Appert are typical. The list comprises every dish for the most elaborate dinner, from the relish, running the gamut of soups, fish, meats, game, fowl, vegetables, fruits, desserts, to the cheese. All prepared appropriately so that the dish is ready to be served, needing only the heating or cooling required by that freshly prepared. On reading the list and visualizing the contents of the various jars and cans, one is more than ever inclined to agree with Alexander Dumas that the inclination for cookery, like that for poetry, comes from Heaven, and that the person who devotes himself to such work unselfishly and in the spirit of the investigator, as did Nicolas Appert, is deserving of lasting gratitude and is undoubtedly a “Benefactor of Humanity.”

This appraisal of the work of Appert appeared in part in A Complete Course in Canning. 1924.
Preserving Fruit Without Sugar

Five Guineas were this Session voted to Mr. Thomas Saddington, No. 73, Lower Thames Street, for a Cheap Method of Preserving Fruit without Sugar, for House Use or Sea Stores. The following Communications were received from him, and Bottles of Fruits thus Preserved are placed in the Society's Repository.

Sir,

I shall be much obliged to you to lay before the Society of Arts, &c., the inclosed communication, and a box containing the following fruits in bottles, preserved without sugar, namely, apricots, gooseberries, currants, raspberries, cherries, Orleans plums, egg plums, greengages, damsons and Siberian crabs. I have also sent some fresh English rhubarb plant, preserved in a similar manner. The same mode is applicable to other English fruits, as cranberries, barberries, and many more. This manner of preserving fruit will be found particularly useful on ship-board for sea stores, as the fruit is not likely to be injured by the motion of the ship, when the bottles are laid down on their sides, and the corks kept moist by the liquor, but on the contrary will keep well even in hot climates.

The cheapness of the process will render it deserving of the attention of all families from the highest to the lowest ranks of society. If the instructions I have sent are well attended to, I have no doubt that whoever tries my method will find it to answer his expectation.

I am, Sir,

Your most obedient humble Servant,

Thomas Saddington.

London, Jan. 8, 1808.
To C. Taylor, M.D. Sec.

A New Method to Preserve Various Sorts of English Garden and Orchard Fruits, Without Sugar

Gentlemen,

The general utility, as well as luxurious benefit, arising from the fruit produced by our gardens and orchards, is well known and acknowledged at the festive board of every family; nor is this utility and benefit less manifested by a desire of many persons to preserve them for culinary purposes, in the more unbountiful season of the year; and I am well persuaded that this commendable desire would be greatly extended in most families, was it not attended with so much expense as is generally the case by preserving fruit in the common mode with sugar, that article chiefly constituting the basis by which it is effected. In addition to the expense of sugar, which is frequently urged as a reason for not preserving, there are other objections to that method, and what I am about to mention cannot be considered as the least, namely, the great uncertainty of success, occasioned by the strong fermentable qualities contained in many sorts of fruit. It may be said by some, that fruit may be preserved for a length of time
without sugar by the ordinary mode of baking or boiling and being closely
stopped up, to which assertion I freely assent; but even that method is
frequently attended with uncertainty, for if the cork or other means used
for keeping the external air out of the vessel becomes dry, or from any
other cause the atmospheric air exchanges place with what is impregnated
by the fruit, it soon becomes mouldy and unfit for use.

From these considerations, and a desire of preserving fruit at a trifling
expense, I have made various and successful experiments of doing it with¬
out sugar, and at the same time with a certainty of their retaining all those
agreeable flavors which they naturally possess; and it is highly probable
that they will keep perfectly good for two or three years, or even a longer
period, in any hot climate, by which it appears to become a valuable store
for shipping or exportation, as I have exposed them to the action of the
meridian sun in an upper room, during the whole of the summer, after
they have been so preserved (being done in 1806). I have now the pleasure
of laying before the Society specimens of the fruit alluded to.

Process for Preserving Fruit

The bottles I chiefly use for small fruit, such as gooseberries, currants,
cherries, and raspberries, are selected from the widest necked of those used
for wine, or porter, as they are procurred at a much cheaper rate than
what are generally called gooseberry bottles. Having got them properly
cleaned, and the fruit ready picked, (which should not be too ripe,) fill
such of them as you intend doing at one time, as full as they will hold,
so as to admit the cork going in, frequently shaking the fruit down whilst
filling. When done, fit the corks to each bottle, and stick them lightly in,
so as to be easily taken out when the fruit is sufficiently scalded, which
may be done either in a copper, or large kettle, or saucepan over the fire,
first putting a coarse cloth of any sort at the bottom to prevent the heat
of the fire from cracking the bottles; then fill the copper, or kettle, with
cold water sufficiently high for the bottles to be nearly up to the top in it;
put them in sideways to expel the air contained in the cavity under the
bottom of the bottle; then light the fire if the copper is used, taking care
that the bottles do not touch the bottom, or sides, which will endanger their
bursting; and increase the heat gradually until it comes to about one hun¬
dred and sixty, or one hundred and seventy degrees, by a brewing ther¬
mometer, which generally requires about three quarters of an hour. For
want of such an instrument it may be very well managed by judging of
the degree of heat by the finger, which may be known by the water feeling
very hot, but not so as to scald it. If the water should be too hot, a little
cold may be added to keep it of a proper temperature, or the fire may be
slackened. When it arrives at a sufficient degree of heat, it must be kept
at the same for about half an hour longer, which will at all times be quite
enough, as a longer time, or greater heat, will crack the fruit. During the
time the bottles are increasing in heat, a tea-kettle full of water must be got
ready to boil as soon as the fruit is sufficiently done. If one fire only is used,
the kettle containing the bottles must be removed half off the fire, when it
is at the full heat required, to make room for boiling the water in the tea¬
kettle. As soon as the fruit is properly scalded, and the water boiling, take
the bottles out of the water one at a time, and fill them within an inch of
the cork with the boiling water out of the tea-kettle. Cork them down im-
mediately, doing it gently, but very tight, by squeezing the cork in, but you must not shake them by driving the cork, as that will endanger the bursting of the bottles with the hot water; when they are corked, lay them down on their side, as by that means the cork keeps swelled, and prevents the air escaping out: let them lay until cold, when they may be removed to any convenient place of keeping, always observing to let them lie on their side until wanted for use. During the first month, or two, after they are bottled, it will be necessary to turn the bottles a little round, once or twice in a week, to prevent the fermentation that will arise on some fruits from forming into a crust, by which proper attention, the fruit will be kept moist with the water, and no mould will ever take place. It will also be proper to turn the bottles a little round once or twice in a month afterwards.

Having laid down the method of preserving fruit without sugar, in as clear and concise a manner as possible, I will recapitulate the whole in a few words, which may be easily remembered by any person. Fill the bottles quite full with fruit. Put the corks in loosely. Set them in a copper, or kettle of water. Increase the heat to scalding for about three quarters of an hour; when of a proper degree, keep at the same half an hour longer. Fill up with boiling water. Cork down tight. Lay them on their side until wanted for use.

It may be said as an additional reason as well as cheapness, for using wine, or porter bottles, instead of gooseberry, is the difficulty of obtaining them, even at any price, in some parts of the country, and indeed they are equally useful for small fruit, and answer the purpose quite as well, excepting the little inconvenience of getting the fruit out when wanted for use, which may be easily done by first pouring all the liquor out in a bason, or any other vessel, and then with a bit of bent wire, or small iron meat skewer, the fruit may be raked out. Some of the liquor first poured off, serves to put into the pies, tarts, or puddings, instead of water, as it is strongly impregnated with the virtues of the fruit, and the remainder may be boiled up with a little sugar, which makes a very rich and agreeable syrup.

In confirmation of the foregoing assertions, I now produce twenty-four bottles as samples, containing twelve different sorts of fruit, viz. apricots, rhubarb, gooseberries, currants, raspberries, cherries, plums, Orleans plums, egg plums, damsons, Siberian crabs,* and green-gages—which have all been preserved in the manner above described.

In order to diversify the degree of heat, and time of continuance over the fire, I have done some in one hundred and ninety degrees, and continued them in it for three quarters of an hour, from which experiments it is evident that the heat is too powerful, and the time too long, as the fruit by that degree and continuance is rendered nearly to a pulp.† In the summer of 1807 I preserved ninety-five bottles of fruit, the expense of which, (exclusive of bottles and corks), was 1 £ 9s. 5½d.; but having some fruit left, it will not be right to judge them at a higher rate than 1 £ 9s.; and allowing 5s for the extra coals consumed in consequence of my not having a conven-

*Apples and pears may be done for shipping, etc.
†Some of these samples of 1807 were done in 180 and 190 degrees.
is nearly \(4\frac{1}{2}\) d. per bottle, exclusive of the trouble of attending them; but if we estimate their value in the winter season, at 1s. per bottle, that being in general as low or lower than the market price, they will produce 4£ 15s. but losing one bottle by accident, reduces it to 4£ 14s. leaving a net profit of 3£ on ninety-four bottles, being clear gain of nearly two hundred per cent. Another great advantage resulting from this statement will appear by making it an article of store for shipping, or exportation; and I shall submit a few ideas tending to promote such a beneficial object by doing it in large quantities; for which purpose sufficiently extensive premises must be fitted up, with a proper number of shelves, one above another, at a distance of about five inches.

The vessel for scalding the fruit in, should be a long wooden trough of six, eight, or ten feet in length, two or three in breadth, and one in depth, fitted with laths across to keep the bottles upright, and from falling against one another; this trough of water to have the heat communicated to it by steam, through a pipe from a closed boiler at a little distance. The boiling water wanted to fill the bottles with, may be conveyed through a pipe and cock over the trough, by which arrangement, many hundreds of bottles might be done in a short time. It may be prudent to observe that this idea is only speculative, not having been actually practised, but at the same time seem to carry with them a great probability of success, and worthy the experiment.

It remains now that I state some reason or object for troubling the Society, whom I have taken the liberty to address with these communications. The first is a desire of publicity, sanctioned by their investigation of the experiments made for preserving fruit without sugar, thereby lessening the expense attending an object of so much public benefit and utility. The second arises from a personal or private consideration; but on this subject I shall only observe, that I wish to throw myself entirely on that protection which has ever characterised the liberality of the Society; and that I shall feel highly honoured if they conceive what I have communicated deserving any mark of their favour.

I am, Gentlemen,

Your most obedient humble Servant,

THOMAS SADDINGTON.

Wood Street, London,
January 1, 1808.
To the Society of Arts, &c.
Disclosure of the Basis for the First English Patent on Canning

A.D. 1810 . . . . . . N° 3372.

Preserving Animal and Vegetable Food.

DURAND'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, Peter Durand, of Hoxton Square, in the County of Middlesex, Merchant, send greeting.

WHEREAS His most Excellent Majesty King George the Third did, by His Letters Patent under the Great Seal of the United Kingdom of Great Britain and Ireland, bearing date at Westminster, the Twenty-fifth day of August, in the fiftieth year of His reign, give and grant unto me, the said Peter Durand, my exors, admors, and assigns, His especial license, full power, sole privilege and authority, that I, the said Peter Durand, my exors, admors, and assigns, during the term of years therein mentioned, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, an Invention communicated to him by a certain foreigner residing abroad, of the Method of "Preserving Animal Food, Vegetable Food, and other Perishable Articles a long Time from perishing or becoming useless;" in which said Letters Patent there is contained a proviso obliging me, the said Peter Durand, by an instrument in writing under my hand and seal, to cause a particular description of the nature of the said Invention, and in what manner the same is to be performed, to be inrolled in His Majesty's High Court of Chancery within six calendar months after the date of the said recited Letters Patent, as in and by the same, relation being thereunto had, may more fully and at large appear.

NOW KNOW YE, that in compliance with the said proviso, I, the said Peter Durand, do hereby declare that the nature of the said Invention, and the manner in which the same is to be performed, are particularly described and ascertained as follows, that is to say:—
First, I place and inclose the said food or articles in bottles or other vessels of glass, pottery, tin, or other metals or fit materials; and I do close the aperture of such containing vessels so as compleatly to cut off and exclude all communication with the external air; and as to the method of closing, I do avail myself of the usual means of corking, airing, luting, or cementing, and in large vessels I make use of corks formed of pieces glued together in such a manner as that the pores of that substance shall be in a cross direction with regard to the aperture into which such cocks are to be driven; and I do also in such vessels as may admit of or require the same, make use of stoppers fitted or ground with emery, or screw caps with or without a ring of leather, or other soft substance between the faces of closure, and also of cocks or cross plugs or covers of leather, cloth, parchment, bladder, and the like.

Secondly, when the vessels have been thus charged and well closed, I do place them in a boiler, each separately surrounded with straw or wrapped in coarse cloth, or otherwise defended from striking against each other, and I fill the said boiler so as to cover the vessels with cold water, which I gradually heat to boiling, and continue the ebullition for a certain time, which must depend upon the nature of the substances included in the vessels, and the size of the said vessels, and other obvious circumstances which will be easily apprehended by the operator without farther instruction. Vegetable substances are to be put into the vessel in the raw or crude state, and animal substances partly or half cooked, although these may also be put in raw. The food or other articles thus prepared may be kept for a very long time in a state fit for use, care being taken that the vessel shall not be opened until their said contents shall be wanted for consumption.

And, lastly, I do declare, that although the application of the water bath, as herein-before described, may be the most commodious and convenient, I do likewise avail myself of the application of heat by placing the said vessels in an oven, or a stove, or a steam bath, or any other fit situation for gradually and uniformly raising the temperature of the same, and suffering them to cool again; and farther, that I do, as the choice of the consumer or the nature of the said food or other article may render preferable, leave the aperture of the vessel, or a small portion thereof, open until the effect of the heat shall have taken place, at which period I close the same.

In witness whereof, I, the said Peter Durand, have hereunto set my hand and seal, the Thirtieth day of August, in the year of our Lord One thousand eight hundred and ten.

PETER DURAND, (l.s.)

AND BE IT REMEMBERED, that on the Thirtieth day of August, in the year of our Lord 1810, the aforesaid Peter Durand came before our said Lord the King in His Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified, in form above written. And also the Specification aforesaid was stampt according to the tenor of the Statute made for that purpose.

Inrolled the Thirtieth day of August, in the year of our Lord One thousand eight hundred and ten.

ALEXANDER.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE, Printers to the Queen's most Excellent Majesty. 1855.
Discussion of Food Conservation and the Work of Appert in the Edinburgh Review, April, 1814

The most philosophical definition, as well as the most honourable prerogative of man, as is well known to every member of the Common Council, is, that he is "a cooking animal"; and we believe it may be safely asserted, that he has scarcely ever been found in so very lamentable a state of barbarity, as to swallow his food without some kind of preparation. The art by which this is accomplished, is denominated Cookery; and although, in the present state of European society, its actual practitioners are held in little estimation, yet, in the earlier ages of the world, it was frequently exercised by persons of the greatest dignity. In the East, at this day, it is confined to a particular caste, and, like the other more important arts of those countries, descends by succession from father to son. Even among ourselves, those who may think meanly of its practice will scarcely be disposed to question its utility; and with many grave and enlightened persons in our cities and bodies corporate, the gratifications it confers have always been held among the highest pleasures, if not the chief privilege, of office. To the chemist, desirous of tracing the various modifications produced in organized matter by the combined agency of heat and moisture, it presents many curious subjects of observation and research; and the political economist, who justly appreciates the relation in which subsistence stands to population, will not undervalue an art, which, if it add not to the quantity, certainly improves the qualities of our food, and in many instances augments greatly its nutritive powers. If, by an abuse of the art, gout, apoplexy, and other dreaded ills, lurk sometimes in ambush among the dishes, this forms no valid objection against that wholesome exercise of it for which alone we venture to contend; and even under this abuse, there is one learned profession which may be expected to tolerate its existence, since it must ever be the interest of those, whose business it is to cure disease, to regard, with complacency, that art, whose occupation it may be to produce it.

Looking, then, on the cook as a sort of manufacturer who prepares and works up the raw produce of the husbandman for the daily use and accommodation of the great body of consumers, we must esteem his art as one of no mean importance. As, however, a considerable time often intervenes between the production of different articles of subsistence and their actual consumption, and as the wants and occupations of mankind frequently impose on them the necessity of storing up the super-abundant produce of one period to meet the exigencies of another, it becomes likewise of importance to ascertain the best methods of preserving such articles, either as nearly as possible in their original state; or in some other in which, though their form and properties be altered, their nutritive powers may be retained. By such means, not only may the more perishable alimentary substances of one season be reserved for consumption at another, but the superfluous productions of distant countries be transported to others, where they are more needed. To mariners, in particular, every means of preserving articles of subsistence in a recent state, must present an object
of great interest; and even though this should not be practicable to the extent of supplying daily food for a large crew, yet an occasional use of such food would be at all times a great luxury, and, in many cases of sickness and disease, essential, perhaps, to the restoration of health. We agree, therefore, with the author of this little volume, in thinking, that “a method of preserving animal substances, and all kinds of vegetables, with all their natural qualities and virtues,” is an art which may often be the means of relieving humanity, and of affording, occasionally, no inconsiderable aid to medicine.

The processes instituted with this view by M. Appert, and communicated to the public in the work before us, were exhibited to the Board of Arts and Manufactures in France;—who authenticate, with their names, the details and results of the method. A Committee of the “Society for the Encouragement of National Industry,” furnish likewise a report of an examination of various animal and vegetable substances, which had been thus preserved. Among the signatures to these reports, we recognize the well-known names of Guyton-Morveau, Gay-Lussac, and Parmentier,—all of whom bear witness to the general success of the experiments. Committees, nominated by the Maritime Prefects of Brest and Bourdeaux, add their testimony to the same purport: and Admirals Martin and Allemand speak of the infinite advantage which it holds out to the sick at sea, and the interest it must excite among seamen in general. The latter officer concludes a letter to our worthy Restaurateur,—in gratitude, we presume, for the solid gratification he had derived from the art, by praying him “to accept the assurance of his high consideration.” And lastly, the Minister of the Interior, deeming it of importance that a knowledge of the process should be spread abroad, desires our author to draw up a detailed and exact description of it; and, on the recommendation of his Council, awards him, from the public treasury, a recompense of 12,000 francs.

With such testimonials in favour of the process, and such opinions respecting its importance, we have thought that a brief account of the methods of M. Appert might not be unacceptable to our readers. We do not, however, concede to the author the claim of originality which he so strongly urges. Experience in this, as in other arts, had already made known many practices of great value, which, in all essential circumstances, accord with the methods employed by our author. We give him full credit, however, for improving, in some respects, the several stages of the process; and, in particular, for extending it to many substances, to which, on the large scale at least, it had never before been applied. Of his attempts to assign the rationale of his process, we do not, for reasons hereafter to be stated, think so highly. In the meantime, not confining ourselves to the single mode of preserving animal and vegetable substances recommended by our author, we shall review various other methods of still greater efficacy and simplicity, endeavouring, at the same time, to reduce them to some general rules, and offering such occasional explanations as may tend to the simplification or improvement of the processes themselves, or the extension of them to other objects.

In general, the animal and vegetable substances used as food for man, have suffered a violent and premature death; but, in other instances, they are permitted to arrive at full maturity. Many of these substances, as the
seeds of vegetables, and the eggs of birds, though apparently destitute of life, possess the faculty of exhibiting living action, if duly exposed to the combined operation of moisture, heat, and air; while others, if placed in similar circumstances, exhibit none of the phenomena of life, but undergo spontaneous changes of decomposition, by which their sensible qualities are essentially altered, and new products, altogether unfitted for the purposes of nutrition, are formed. In this manner, the same agents which in certain bodies, give rise to the phenomena of life, promote, in others, those changes which end in decomposition. It is to prevent the occurrence of this latter series of changes, that the several methods of preserving organized substances, have been had recourse to. These methods will, of course, vary according to the nature of the substance, the knowledge, and even the taste of the preserver, and the particular purpose which he may have in view: they will also, in many instances, be regulated by local wants, and by circumstances of situation, climate, &c. In every case, however, the more complete is our knowledge of the nature of the substances to be preserved, of the properties of the agents by which they are affected, and of the reciprocal influence which these substances and agents exert on each other, the more easily shall we be able to devise means for obtaining the desired end, and for excluding all circumstances which are either not necessary to, or might impede its accomplishment.

For the sake of convenience, we may distinguish the methods employed for the preservation of animal and vegetable substances into natural and artificial. To the former belong those which accomplish their purpose by the simple abstraction or exclusion of one or more of the three great agents of heat, moisture, and air—which so powerfully contribute to produce decomposition: the latter embrace those modes of preparation and mixture which have a tendency to resist fermentation and putrefaction. The natural methods, where they can be practised, are by far the most efficient and least expensive; and the substances, so treated, frequently suffer little or no deterioration of their qualities, however long they may be kept in such a state. Even where the artificial modes are employed, it is almost always necessary to aid their operation by excluding, to a certain degree, some one or more of the natural agents. Before proceeding to the artificial modes, we shall bring before our readers a few examples of the preservation of animal and vegetable substances by natural methods; and, first, of that which effects its purpose by the simple abstraction of heat.

That a moderate degree of cold conduces much to the preservation of inanimate bodies, is a fact familiar to every one; and in general the lower the temperature is, the more effectually are the substances preserved. Such a moderate reduction of temperature acts simply by checking or suspending that chemical action which goes on spontaneously in all organized bodies when they are exposed, in favourable circumstances, to the combined operation of heat, moisture and air; and which at length terminates in that complete change of their condition and properties which we denominate putrefaction.

When the abstraction of heat is carried so far as to congeal the juices of the animal substance, and which requires a degree of cold several degrees below the freezing point of water, its preservation is then more completely accomplished. Mr. Boyle mentions many instances of eggs, fish and flesh
being preserved for a long time in a frozen state. About the end of October, the Russians, according to Dr. King, kill their poultry, and pack them in tubs with layers of snow betwixt them, using them afterwards as occasion requires. Veal frozen at Archangel, and brought to Petersburgh, is esteemed the finest they have; nor, when properly thawed, can it be distinguished from that which is recently killed, being equally juicy. It is in this manner that the markets are supplied, vast stacks of whole hogs, sheep, and fish being in this state exposed to sale. When animal substances are thus submitted to an extreme degree of cold, they seem capable of being preserved for an indefinite period of time. Thus Pallas mentions the fact of a rhinoceros that was found on the banks of a river that falls into the Lena, below Jacutsk. The carcass, was at first almost entire, and was covered with the hide; and some of the muscles and tendons were actually adhering to the head when Pallas received it. The preservation of this natural mummy, says Professor Playfair, was no doubt brought about by its being buried in earth that was in a perpetual state of congelation: for the place is in the parallel of 64°, where the ground is never thawed but to a very small depth below the surface. A still more remarkable discovery of this kind was made in 1799, on the shores of the Frozen sea, near the mouth of the same river Lena, which is one of the largest in Siberia. An animal of uncommon size was found imbedded in a mass of ice, which, as it melted, gradually disclosed him to view. His hair, skin, and flesh were in good preservation; so that dogs and many wild animals preyed upon it. The block of ice in which he was found was upwards of 200 feet high, and, when first discovered, he appears to have been about 40 feet beneath its surface. According to the celebrated Cuvier, this animal differs from every species of elephant, as well as from the large animals whose bones have been found on the banks of some of the great rivers in America. He bears indeed no resemblance to any species of animal at present known on the surface of the earth; and is therefore considered by Cuvier as ante-diluvian, and to have been preserved from the remote period of the Deluge in the mass of ice that enveloped him. Vegetable substances, in like manner, may be thus preserved in a frozen state. Mr. Boyle mentions examples of apples that had been frozen, and which, by proper management in thawing, were restored to their former freshness; and grapes and cabbages that have been quite frozen, are said by Dr. King to be as good as when recently gathered, if they are properly thawed. This extreme degree of cold, by which the fluids of animal and vegetable substances are entirely congealed, puts a stop to all chemical action; and so long therefore as it continues, the bodies exposed to its influence may be expected to retain entire their chemical constitution.

Wherever a great degree of cold has thus been employed in the preservation of animal and vegetable substances, it is of the utmost importance to attend to the manner in which heat is subsequently restored: for the effects of that subtle agent are wonderfully modified according to the greater or lesser rapidity with which this restoration is made. Mr. Boyle found, that if eggs and apples, which had been frozen, were put into a dish of very cold water, a crust of ice formed around them; they became softer, and were gradually restored to their former state: but if placed by the fireside, putrefaction, says he, was soon induced in them by such an overhasty thawing. He adds, that if frozen fish and meat be leisurely
thawed, it is little impaired; but if, before it has been thawed, it be laid
down to the fire, it is then very slowly roasted, and eats afterwards very
badly. Dr. King confirms these statements of Mr. Boyle,—observing that
the method of thawing frozen bodies must be by immersion in cold water;
that heat excites putrefaction; but when the thawing is produced by cold
water, "the ice seems to be attracted out of the body, and forms an incrus¬
tation around it." This crust of ice is not, however, formed by the attrac¬
tion of cold from the frozen body, but of heat from the water, which, by
thus losing its caloric of fluidity, passes into the state of ice; and the tem¬
perature of the frozen body, by the caloric it thus receives, is at the same
time raised.

In the more temperate climate of this country, we seldom attempt to
preserve animal substances for any length of time by a simple reduction of
temperature, though the expedient is perhaps worthy of more attention
than it has yet received. In one important instance, however, the Russian
practice has been followed with great advantage. We allude to the mode
of preserving fish, now adopted on all the eastern rivers and coasts of Scot¬
land. and, we believe, in some parts of Ireland, by which means salmon is
conveyed fresh to the capital of the empire. The practice is said to have
been first recommended by a public spirited country gentleman in Scot¬
land, Mr. Dempster of Dunichen; and its adoption has been to many a
source of great private emolument, and productive of much national bene¬
fit. Every salmon fishery is now provided with an ice-house, for laying in
a stock of ice during the winter. The salmons are packed in large oblong
wooden boxes, with pounded ice interposed betwixt them; and in this
manner they are conveyed to London as fresh as when they were taken out
of the water. We have understood, however, that though they may thus
reach London perfectly fresh, they do not always come to table in so good
a state as salmons that have not previously undergone the freezing process,
which, from what has been already stated, may fairly be presumed to arise
from inattention in restoring the heat, or ignorance of the principle on
which its restoration should be made. Till the introduction of the practice
just mentioned, ice-houses were possessed chiefly by the opulent, and
applied only to purposes of luxury. It is not unlikely that they will, ere long,
be extended to the preservation of other necessaries of life: for what
advantage does the fish-merchant derive from them, which the dealer in
other animal substances might not equally obtain?

As to vegetable substances, so far from desiring to preserve them by the
aid of a freezing process, it is usual, in this country, to employ more or less
care in endeavouring to protect them from it. Farmers and gardeners are
thus in the practice of storing up potatoes, turnips, and other vegetables for
winter food, both for men and cattle. These vegetables are commonly laid
in pits, and covered with earth, and often with straw, or some other light
material. It frequently happens, however, that the cold penetrates, or in
other words, the heat is drawn off through the covering, and the vegetables
beneath are more or less frozen. This may sometimes arise from the in¬
sufficient or improper nature of the covering employed, which should al¬
ways consist of light materials, since these best resist the entrance of cold;
or, to speak more correctly, the escape of heat. Beside straw, the earth that
is used should therefore be light and dry, and such as may not be apt to
cake, or be retentive of moisture. A close clayey covering, though appar-
ently the most secure, is that which possesses the best conducting power, and therefore most readily permits the escape of heat from the bodies beneath it. Well dried peat, from its great lightness, and little disposition to retain moisture, forms an excellent covering. Straw, or other similar vegetable substance, covered by earth, is an excellent protection as long as it continues dry; but if it becomes thoroughly wetted, its non-conducting power is in a great degree lost; and if, at the same time, it enter into fermentation, the heat then disengaged will contribute to excite vegetation, by which the qualities of the substances beneath are much changed. Perhaps, therefore, where straw is used, it might be safest to employ it as the outermost covering, in which way it may do much good, and cannot, under any circumstances, do harm. The propriety of employing a light and porous earth on such occasions will, perhaps, be best shown by stating the results of a few observations, made in this neighbourhood in the month of January last, to ascertain the penetration of the late severe frost into different sorts of soil, and communicated to us by a friend on whose accuracy we can rely. In a stiff clayey soil, the frost was found to have penetrated to the depth of 2 feet 6 inches. In a naked clayey loam, it had reached to 10 inches; and in a contiguous and similar soil, in ley, and covered with grass, 7 inches. In the garden ground of a high situation it was traced to the depth of 9 inches; and under the adjoining uncultivated soil, covered with grass only, to between 6 and 7 inches; so that the more light and porous the earth was, the more slowly did it lose its heat, and the better, of course, would it have protected from external cold any substances buried beneath it. An exterior coat of grass, as might be expected, seems also to have improved its non-conducting power. If, notwithstanding every precaution, vegetables that have been buried still become frozen, immersion of them in cold water, in the manner already recommended, should be practised. By such means they will speedily be brought to the temperature of that fluid; for water, from the facility with which it communicates heat, and the large quantity it gives out on passing to the state of ice, thaws frozen bodies, as Mr. Boyle has remarked, much more rapidly than air. The tendency to decomposition, from the sudden application of heat to bodies in a frozen state, will thus be checked or prevented; and experience amply confirms the success of the practice. It is almost needless to add, that the same covering which best secures buried vegetables from the effects of cold, when the temperature of the atmosphere is lower than that of the earth, is, for the same reason, best fitted to resist the penetration of heat; when, on the approach of spring, the relative temperature of the earth and air are reversed, and consequently, to check in such vegetables the disposition to premature vegetation.

We have represented a freezing temperature to act, in the preservation of organized substances, by removing that moisture which is essential to chemical change. A similar result is obtained, but with phenomena very different, if the moisture be abstracted by other means. In those parts of the earth where little rain falls, and extensive plains of sand occur, the air that blows over them is rendered exceedingly dry; and possessing, therefore, a great affinity for moisture, greedily attracts it from all substances with which it comes in contact. These drying winds are observed in various parts of the globe. In the East and West Indies, in Egypt, on the shores of the Mediterranean, and on various parts of the coast of Africa, such
winds, at particular seasons, prevail. In some situations their temperature is moderate; but, from the drying operation on the skin, they cause a sensation of heat; in others, their temperature is higher than that of the human body, so that every substance feels hot to the touch. Their general effect on the face of the country is to produce great dryness: the grass withers and becomes like hay: the branches of trees droop: and, if the wind continues ten or twelve days, their leaves become so parched as to be easily rubbed to dust between the fingers: wooden furniture warps and shrinks, so that the nails fall out of it: the panels of doors and of wainscot split, and the joints of floors open wide enough to admit the finger: the covers of books, even when shut up in trunks and surrounded with clothes, are bent as if they had been exposed to the fire.

On animal bodies, its parching effects are not less striking. The eyes, nostrils, lips and palate, are rendered dry and uneasy: drink is required, not so much to allay thirst, as to remove the painful sensation of aridity in the fauces. The lips and nose are frequently chapped; and, in four or five days, if the wind continues violent, the skin peels off, first from the hands and face, and afterwards from other parts of the body. Sometimes its sudden approach destroys men and animals, by producing suffocation: and, what is more to our purpose, the carcases of camels and other creatures which lie exposed in the deserts, by being quickly drained of that moisture, which would otherwise dispose them to putrefaction, are thereby put, says Dr. Shaw, into a state of preservation, and will continue a number of years without mouldering away. "I have been credibly informed," he adds, "that, at Saibah, which lieth about the half way betwixt Ras Sem and Egypt, there are a number of men, asses, and camels, which have been preserved from time immemorial in this manner. They are supposed to have belonged to some caravan or other, which, in passing over these sandy deserts, was suffocated by the hot burning winds that now and then infest these sandy countries." Thus, the complete abstraction of moisture under a high degree of heat, as effectually prevents putrefaction as when its operation is arrested by extreme cold.

Our insular situation and great distance from these sandy deserts protect us from their baneful influence; the air being pretty well saturated with moisture before it can reach our shores. Even here, however, the east wind, which blows from a vast extent of continent, is proverbially said to be dry; and its withering and parching operation on the leaves of vegetables in spring, is frequently productive of much mischief. In the desiccation of substances by means of air, we are accustomed to trust rather to a free exposure, and the operation of currents in the atmosphere, than to its state of dryness. It is in this manner that fish and some other animal substances are preserved, simply by exposing them so as to evaporate their moisture; in which state, if they are kept dry, they resist all farther change. Many kinds of meat are dried by artificial heat, as bacon, beef, &c.: but the rapid tendency to putrefaction in animal substances, renders it necessary to employ a portion of salt, in conjunction with the simple process of drying. This, however, where the desiccation can be effected with sufficient rapidity, is quite unnecessary. The conditions favourable to this operation are, a pretty high temperature, a dry state of the atmosphere, and a frequent change or current of air. The high temperature promotes the effect, by increasing the solvent power of air for moisture; and this is farther
augmented, if the air be, at the same time, dry, and a frequent change of
surface occur in it. But in this mode of preservation, the juices of the meat
are in great part dissipated, and its flavour is considerably impaired:
Neither, by the subsequent restoration of moisture, is the animal fibre re-
stored to its former state of freshness, as happens to frozen substances
from the reapplication of heat. Such substances are therefore less nutri-
tious than in their recent state, and are with more difficulty acted on by
the digestive organs.

The employment of this method in the preservation of vegetable sub-
stances, is practised to a great extent. The tendency to putrefaction in
these bodies is much less than in animal substances; and the smallness of
their bulk, or rather the thinness of their form, favours much their com-
plete desiccation. Neither, by this process, do their more fixed ingredi-
ents suffer so much loss or change of properties as those of animal sub-
stances; and consequently, their nutritive powers are not so much im-
paired. The most important vegetable substances preserved in this way, are
the Gramineae, in the state either of corn or hay. The stems and seeds of
these vegetables keep, as is well known, for a long time, if they are well
got in, and properly stored. In the condition of grain, it is desirable that
no alteration should take place, after it is once put into stack; but the
qualities of hay are certainly much improved by its undergoing a gentle
fermentation. In those districts of England where cattle are fattened on
hay alone, great attention is given, that, in the making of it, the natural
juices be so far preserved that it may properly heat, as it is called, in the
stack. By this process of heating, the colour of the hay is deepened, its
weight is increased, and it is rendered sweeter, the mucilage and starch of
the stems and seeds being probably converted into saccharine matter, as
occurs in the process of malting, or in the methods lately discovered of
converting starch into sugar by the long-continued operation of heat and
moisture. Sometimes, indeed, from unfavourable seasons, or from negli-
gence in the making, the hay is not sufficiently dried; and the fermentation
then excited disengages so much heat as to consume the whole by a slow
and smothered combustion, reducing it to the state of a dry charcoal. If,
at this period, air be admitted into the mass, it breaks out into flame. The
great heat thus manifested arises probably from the condensation of water,
which, during the fermentation, is found entirely to disappear. Mr. Leslie
has shown, that the simple absorption of a few drops of water, by a bit
of very dry wood, paper, or linen, produces a considerable elevation of
temperature; and the heat liberated when water is rendered solid in the
slaking of lime is familiar to every one.

Some vegetables, however, as potatoes and turnips, may be preserved
a long time without change, though containing a large portion of water;
but could they be deprived of this water, their preservation would be more
easily and certainly accomplished, and their transportation greatly facili-
tated. A process for effecting this purpose, was proposed some years ago,
by Mr. Forsyth, advocate. It consisted in first cutting or breaking the
potatoes into small pieces, and then dissipating their water, by exposing
them on a metallic plate, heated by the steam of boiling water. In this man-
nner, they may be rendered dry, without risk of burning or scorching; and
the flour or meal they yield, is said to have no disposition to attract moist-
ure; and if closely packed, may be preserved for any length of time. This
process seems to be simple and efficacious; and might be advantageously
used for the desiccation of any other vegetable substance; but it is probable
that the labour and expense attending it, will prevent its employment to
any great extent in ordinary life. It seems, however, worthy the attention
of mariners, who may desire to possess vegetable substances in a state
adapted to keep through long voyages.

As the air, in a state of dryness, so powerfully abstracts moisture from
bodies, and thereby suspends in them the disposition to chemical change,
another mode of preserving certain vegetable substances might probably
be employed with advantage. The more delicate and perishable fruits, as
apricots and peaches, which decay speedily after having reached the full
period of maturation, might have their existence prolonged, by confining
them in a moderately dry atmosphere. This might be accomplished, by
placing them in an inverted receiver, within which some substance, possess¬
ing a strong affinity for moisture, as lime or its muriate, or sulphuric acid,
was contained. In this manner, the atmosphere would be kept so dry, as
not to favour that reciprocal action between such bodies and the air, which
the experiments of different chemists show ordinarily to take place. If,
with this dry state of the air, a low temperature was conjoined, the preser¬
vation of such perishable commodities would doubtless be promoted. The
same method might be used by botanists in the preparation of plants for a
hortus siccus; and, with a little experience, it is probable that flowers might
thus be preserved with less loss of their more delicate colours, than in the
common modes of drying them by heat, or blotting paper. The more odor¬
ous plants, also—such as mint and others, whose *aroma* we may wish to
retain, might be preserved in a similar manner; and probably with less loss
of their volatile ingredients than attends their desiccation in the free at¬
omosphere, or by the method of M. Appert.

There is still a third natural method, by which animal and vegetable sub¬
stances may, in ordinary temperatures, be preserved from putrefaction;
and that is, by the simple exclusion of air. We have examples of it in the
means frequently employed for preserving eggs. The shell of the egg is
composed of earthy matter, which is full of pores, through which pass the
extremities of very minute vessels, that come off from the strong mem¬
brane or tunic with which the shell is lined. Through these vessels, the
watery part of the albumen constantly exhales; and the egg, in conse¬
quence, daily becomes lighter. If, therefore, the mouths of these pores and
vessels be effectually closed, no farther exhalation takes place, and the egg
does not lose weight, nor exert that action on the air, which accelerates its
decomposition. Reaumur employed a spirit varnish for this purpose, and
thus preserved eggs quite fresh for two years: and after carefully remov¬
ing the varnish, he found that such eggs were still capable of producing
chickens. Others employ, with the same intention, some fatty substance
for closing the pores; and others simply immerse the egg for an instant in
boiling water, by which its albumen is in part coagulated, and the power
of exhalation thereby checked. In every case, the intention is simply to
exclude the contact of air, and thereby prevent that reciprocal action be¬
twixt it and the egg, which contributes to produce decomposition. Hence,
whether, as in the foregoing examples, the air be excluded from the egg;
or whether, as by placing it in vacuo, the egg be protected from the air,
the result is the same; and the preservation of the egg will be equally
effected, as far as the exclusion of air can contribute to that end.—Nor is it easy to limit the period to which this may extend, if the surrounding temperature remain low and steady: for Bomare records an instance of three eggs, found enclosed within the walls of a church in the Milanese, which continued perfectly fresh—retaining their natural odour and flavour, after the lapse of 300 years.

A more remarkable preservation of animal substances, by the simple exclusion of air, conjoined with a low temperature, is afforded in the curious facts recorded of toads, serpents, and various other animals which have been found in the hearts of trees or in the center of rocks, within which they have been immured probably many hundred years; and with so little decay of substance or loss of properties that they retained their living faculty, and, by the renewed access of air, recovered their vital functions. To the same class of facts, we may probably refer the well-known story of Dr. Franklin’s flies, which are reported to have recovered life in France, after having made, what some may deem, a very enviable voyage from America, in a cask of Madeira wine. Some of our readers may, perhaps, smile at the recital of such alleged facts, and even deny their possibility, consistently with our knowledge of the laws of animal life. Yielding, however, as we do, entire credit to their reality, we choose rather to consider our knowledge of the laws of life as yet so imperfect, as not to enable us to reduce such facts to consistency with it.

It is but rarely that attempts are made to preserve vegetables by the simple exclusion of air. It is probable, however, that in some fleshy fruits, a method similar to that practised with eggs might be adopted with advantage. Such oranges, lemons, and apples as are kept only for the sake of their pulp and juices, might receive a coating of varnish or oil, and where the rind is not afterwards to be used, could not be injured by such treatment. The ordinary preservation of these fruits seems to be owing partly to the drying of their skins, and partly also to the thickness or compact texture of their coats, which, as Gay-Lussac observes, prevents the access of oxygen gas to their substance, and the fermentation that succeeds. It is probable, he adds, that all sorts of fruits might be preserved a long time in hydrogen and nitrogen gases, provided they had not previously been exposed to the action of oxygen. It is even possible that an animal fluid, such as milk, if it could be obtained without the contact of air, might be preserved a long time without alteration. Currants, cherries, and similar fruits are, we know, sometimes preserved simply by gathering them, when perfectly dry, and putting them very carefully into clean and dry bottles, which are afterwards closely corked and buried in the earth, with the design of keeping them in a low and steady temperature.

More frequently, however, these fruits, after being thus gathered, and put into bottles, are submitted to heat, either by scalding them, as it is called, in a water bath, or by baking them for a certain time in an oven: after which they are closely corked and sealed so as to exclude the air. Many practices of this sort have long been familiar in every family: and a similar one was recommended 30 years ago by the celebrated Scheele, for the preservation of vinegar. He advises that the vinegar, after being put into bottles, be submitted to the boiling heat of a water bath for one hour; and that the bottles be then taken out and corked. Vinegar, after being thus boiled, keeps, says he, for several years, as well in the open air as in half-
filled bottles, without growing turbid or mucilaginous. In the year 1807, Mr. T. Saddington of London, received from the Society of Arts, a premium for "a method of preserving fruit without sugar, for house or sea stores." This method is precisely similar to those just mentioned: but some of the rules for the execution of it are laid down with greater precision. The fruit is directed to be gathered before it is too ripe, and to be then put carefully into bottles, which are to be well filled with it, and loosely corked. These bottles are next to be placed in a kettle, or other vessel filled with cold water sufficiently high to reach to the neck of the bottles: heat is then to be applied, and gradually increased until the water rises to the temperature of about 160 or 170° Fahrenheit. This temperature must be kept up for about half an hour; but it must not be suffered to rise higher, or be continued longer, as it would be apt to crack the fruit. When the fruit has been thus properly scalded, it is directed that the bottles be taken out of the bath, and filled, to within an inch of the cork, with boiling water: They are then to be immediately corked very tight, and laid on their sides, that the water within may swell the cork, not however, as Mr. S. suggests, for the purpose of preventing the "air escaping out," but rather from getting in. In this manner, various fruits may be preserved, which are asserted to retain all the agreeable flavours which they naturally possess, and to keep good, even in hot climates, for two or three years, if the entrance of the external air be precluded. We have been somewhat particular in these details, because the methods correspond, both in intention and execution, with those of M. Appert, to whose more intimate acquaintance we shall now, after this long preface, introduce our readers.

M. Appert commences his work with some remarks on the processes at present employed for the preservation of alimentary substances, which he very erroneously reduces to two methods only; these are, desiccation and that of mingling with the preserved substance some foreign ingredient, which may impede fermentation or putrefaction. To the former method, by which smoked and hung meat, dried fish, and many vegetables are preserved, he objects that it takes away the odour, changes the taste of the juices, and hardens the fibre: and to the latter methods he also raises specific objections. Sugar, he says, conceals, or in part destroys, other flavours, and is, besides, very costly. Salt communicates an unpleasant acerbity to substances, hardens the fibre, and renders it indigestible. Vinegar can be used only to a very limited extent, and for a few articles. Disposing, in this manner, of the methods in common use, he puts in a pretty bold claim to originality in the invention of his own process. "As far as my knowledge extends," says he, "no author, either ancient or modern, has ever pointed out, or been even led to the suspicion of the principle which is the basis of the method I propose. This method," he adds, "is not a vain theory. It is the fruit of reflection, investigation, long attention, and numerous experiments:" to the improvement of it he has "devoted his fortune and twenty years of labour and meditation:" and the results for more than ten years have led him to the "surprising fact," that by this means "provisions may be preserved for two, three, and even six years." To accomplish these wonders, he professes to have discovered, "1st, That fire has the peculiar property, not only of changing the combination of the constituent parts of vegetable and animal productions, but also of retarding, for many years at least, if not of destroying, the natural tendency of those same products
to decomposition. 2dly, That the application of fire, in a manner variously adapted to various substances, after having with the utmost care, and as completely as possible, deprived them of all contact with the air, effects a perfect preservation of those same productions with all their natural qualities."

Such are the general terms in which his methods are announced; and we are next presented with the rules by which they are to be carried into execution. These consist, first, in enclosing in bottles the substances to be preserved: 2dly, In corking the bottles with the utmost care: 3dly, In submitting the enclosed substances, for a greater or less length of time, to the action of boiling water in a water-bath: and 4thly, In withdrawing the bottles from the water-bath at the period described. M. Appert next conducts his readers into the suite of rooms where these operations are carried on. Desirous, no doubt, of appearing very scientific, he speaks of his "Laboratory," as consisting of four apartments, one of which, however, he somewhat unwittingly describes as furnished with "all kinds of kitchen utensils"; a second is appropriated to the preparation of milk and cream; a third is used for corking and tying the bottles, and putting them into bags: and in the fourth are the large boilers, which are employed as the water-baths. Many articles of apparatus, particularly for corking his bottles, are then described; and some useful hints are communicated on the best form and construction of the bottles to be employed: and on corks, and the method of corking. He then continues—

"The principle," says he, "by which all alimentary substances are preserved and kept fresh, is invariable in its effects. The result in particular experiments, depends upon the fitness of each individual application of the principle to the substance which is to be preserved, according to its peculiar qualities: But in every case, the exclusion of air is a precaution of the utmost importance to the success of the operation; and in order to deprive alimentary substances of contact with the air, a perfect knowledge of bottles and the vessels to be used, of corks and corking, is requisite." "Economy in corks," he adds, "is very unwise, as in order to save a very trifle in the price of the cork, a risk is incurred of losing the valuable commodity it is intended to preserve." "Too much attention," he repeats, "cannot be given to the corking; no circumstance, however minute, ought to be neglected in order to effect the rigorous exclusion of the air." Where solid and bulky substances are to be preserved, jars or wide-mouthed vessels are employed; and the mode of corking these, which he particularly describes, is a matter of greater difficulty. Over the cork, a luting, composed of cheese and powdered lime, is applied. This luting, it is said, hardens rapidly, and resists the heat of boiling water. When the bottles and jars are thus filled, they are next put into coarse linen or canvas bags, in which they are completely enveloped, and which are designed to confine the fragments, if any of them should break in the heating. The jars and bottles are afterwards placed upright in a boiler, which is filled with cold water up to the neck of the bottles: The boiler is then covered with its lid, and over the lid a wet cloth is spread to impede the escape of vapour. Heat is now applied till the water boils; and the boiling temperature is maintained as long as may be required for the different substances. When that time has elapsed, the fire is immediately extinguished: In a quarter of an hour more, the water is drawn off from the boiler; after the water has been removed for
half an hour, the boiler is uncovered, but the bottles are not taken out for one or two hours more. Such is the general account of the method. Our readers may, however, wish to taste of Mr. Appert's cookery. This laudable inclination we shall be happy to indulge, and shall accordingly serve up one or two dishes for their gratification.

To preserve boiled meat (Pot-au-Feu de ménage) he puts a quantity of it into the pot, the bones having first been removed, to be boiled in the ordinary way. When it is about three-fourths boiled, it is taken out and put into the jars, which are filled with broth, made from other portions of the same meat. The jars are then corked, luted, and put into bags, and are afterwards placed in a boiler of cold water. Heat is then applied till the water boils; and the boiling temperature is kept up for an hour. The fire is then extinguished, the water drawn off from the boiler, its lid removed, and the bottles or jars taken out at the time specified, and set aside till required. Gravy and broth, after being strained, are treated in a similar way, when preserved alone. These more liquid sorts of food, and the juices also of fruits, may be boiled for two hours in the bath without danger; but other substances are injured by a quarter of an hour, or even a few minutes, too much boiling.

To preserve milk, Mr. Appert evaporated it, in the water-bath, to about half its volume, removing frequently the albuminous matter or skin that appeared on its surface. It was then strained and suffered to cool; and being afterwards put into bottles and properly corked was again submitted to the action of the water-bath for two hours. Thus treated, it kept perfectly sweet for two years: but after some time the cream separated from the serous parts. To prevent this, he added to the evaporated milk, in a second experiment, a small portion of yolk of egg well beaten, which perfectly succeeded. Cream itself, when condensed in the water-bath only about ¼th, and afterwards strained, bottled and treated as above, was perfectly good at the end of two years.

As a sample of his vegetables, we shall select his method of preserving green peas. These he gathers when they are not too young, but of a middling size, and have the finest flavour. They are shelled immediately, and as many as possible are put into bottles, which are corked and exposed to the action of the water-bath for an hour and a half, or, in a dry season, two hours. Windsor beans, either with or without their skins, are treated in the same manner, due attention being always given to the nature of the vegetable, and season of the year. Carrots, potatoes and turnips are first of all half boiled in water, suffered to cool, and then put into the bottles, which are submitted to the action of the water-bath one hour more.

Fruits and their juices are said to require the utmost celerity in all the preparatory stages of the process, and particularly in the application of heat to the water-bath. They should be gathered in the height of the season, but not when too ripe, or they do not pack well in the bottles, and are apt to dissolve from the action of heat. White and red currants, either in bunches or stripped, are put into the bottles as soon as gathered, and shaken down, but not so as to bruise them. The bottles are then corked and put into the bath, which is allowed just to boil: the fire is then extinguished, and the water, in a quarter of an hour more, is drawn off. Cherries, raspberries, and other small fruits are similarly treated; but larger ones, as apricots and peaches, are first stoned, and cut into two or more pieces, that they may
pack closer, before they are put into bottles and submitted to the heat of the water-bath. The expressed juices of fruits, after being strained, and bottled, may be preserved by a similar operation.

When animal provisions, which have thus been preserved, are to be used, they require, it is said, only to be properly warmed to produce both soup and meat; for having received three-fourths of their dressing in the preparatory process, and the other fourth in the water-bath, nothing but heating them to the proper degree is necessary, adding such seasoning as may be thought fit. Cream and milk are used in the same manner as in their recent state, or are heated in the water-bath if necessary. As to vegetables, those that have not been at all dressed before being submitted to the preserving process, must be prepared for use accordingly; but those which appear to be already sufficiently boiled, when taken out of the bottle, require nothing more than to be warmed.

A special committee of the "Society for the Encouragement of National Industry" was desired to examine the qualities of the several substances thus preserved, and they report as follows. The meat, when suitably warmed, was tender and of an agreeable flavour, and the soup good; the broth was excellent; the milk, from the condensation it had undergone, was sweeter and more savoury than common; the green peas and Windsor beans, when boiled as directed, furnished two excellent dishes, finely flavoured and agreeable; the cherries and apricots retained a great part of their flavour; and currant and raspberry juices enjoyed all their original qualities. Some of these substances had been prepared eight months; others a year; and others fifteen months; and all of them, at the period of examination, had been two months in the possession of the Society.

Although the process above described is neither novel in principle, nor scarcely in any point of practice, yet it must be allowed that M. Appert has more fully appreciated the value of some of its stages than any of his predecessors, and given to it a much more extensive application. In the selection and preparation of his vessels, and in the stress he lays on the corking of them, he is entitled to much praise. By the methods of potting animal substances and of preserving fruits in this country, the covering of the pots, or corking of the bottles, was delayed till after the heat had been applied, by which means the risk of breaking the vessels, from the expansion of their ingredients during the boiling, was certainly prevented; but the operation of corking could not afterwards be executed with so much safety to the contents; and the temporary access of air, which it permitted, is the circumstance of all others that is most to be avoided. The time required for the application of the heat, and the adaptation of it to different substances, though observed to a certain extent by others, had never before been so correctly ascertained; and the slow cooling, which is afterwards recommended, is not probably without its use. Indeed all the stages of the process are combined and set together in a much clearer light than heretofore, and their relative importance much more justly appreciated. No seasoning or condiments are employed, which, in the common methods of potting, not only added much to the trouble and expense, but so materially altered the properties of the substances, as to adapt them rather to purposes of luxury than of use. We anticipate also the thanks of all prudent housekeepers to Mr. Appert, for showing them that a good cork and a proper
luting may occasion a great saving of butter, employed merely to exclude air.

As to the claim to entire originality set up by our author, we have already in part spoken. We are not enough acquainted with the taste and knowledge of the French ladies, in matters of household economy, to know whether it will pass on the other side of the Channel; but in behalf of our fair countrywomen, we must observe, that, unless they have alike forsaken the example and precepts of their ancestors, they must, in general, be more or less acquainted with the methods of Mr. Appert. We have, indeed, seen it stated, in an excellent little compendium of the culinary art, composed, it is said, by a very respectable lady in the north of England, that "there was a time when ladies knew nothing beyond their own family concerns; but in the present day there are many who know nothing about them." The very extensive sale of the little work just alluded to, we are willing to accept as evidence of a desire, at least, to discredit such a censure: and we venture to predict that every young lady who shall ponder well on the "miscellaneous observations" prefixed to that little volume, will find in them much useful instruction in many circumstances and situations of her future life, for which the "Romance of the Forest," and the "Sorrows of Werter," make no sort of preparation. With all due veneration, however, for the notable housewives of former days, and no small respect for the arts in which they excelled, we do not desire to see the time and faculties of our modern fair devoted exclusively to household arts, and the various modes of domestic industry, in which many of their venerable predecessors wore away the greater part of their lives. We rejoice rather in that progress of the arts which has removed even the pretence for such unprofitable drudgery; and triumph in the reflection, that the mighty powers of the steam engine have been brought to rival in execution the finest works of the needle. The time heretofore unremittingly dedicated to such labours, may surely be more rationally bestowed in the cultivation of the understanding and the taste: and abundant leisure will still be left for the acquisition of all the information in "oecnomics" which it imports a lady to know. Thus may we hope to see combined in the female character, that knowledge which renders life useful and respectable, with those accomplishments which can alone give to it delicacy and grace.

We have now to add a few remarks on the theory of the processes we have just been considering, and on the mode in which the several operations contribute to accomplish their proposed end. As Mr. Appert declares himself to have spent his days in the pantries, breweries, and cellars of Champagne, and in the shops and manufactories of other places, we have no right to look to him for information on this head. He has done his part very well; and has given us many useful rules, and much valuable instruction; and in return for the information we have derived from his experience, we should be happy to afford any hints or explanations which might in any way contribute to the improvement and extension of his labours.

The preservative methods, which have just been described, have been shown to be equally applicable to animal and vegetable substances: and their value, in regard to both, is confined to the prevention of fermentation and putrefaction. Without pretending to much knowledge of the nature of the changes which occur in those curious processes, which are justly
regarded as among the most mysterious in chemistry, we may, by observation and experiment, be able to form pretty correct notions of the agents which act in them, and of the circumstances which best favour that action. Long and familiar experience had led to the conclusion, that these agents were water, heat and air: and the facts stated, of the preservation of substances by the simple exclusion of one or more of those agents, sufficiently attest its truth. A moderate degree of cold, as we have seen, checks or prevents both fermentation and putrefaction: and this it does by suspending, in a great degree, chemical action, and that reciprocal effect which, in favourable circumstances, goes on between bodies and the air. If the temperature be reduced so low as to congeal the fluids in bodies, the preservation of the substances is still more complete; and no change is then produced in the surrounding air. A similar check is imposed on chemical action by the complete removal or abstraction of moisture; for not only a certain temperature, but a certain state of humidity, is indispensable to this action; little or none taking place between bodies and the air when both are in a perfectly dry state. With regard also to the air itself, where its exclusion has been complete, the same preservative power is exerted: but if it once gain admission, even in very small quantities, there is reason to believe that, in many cases, it promotes changes which no subsequent exclusion of it is able to control or prevent. It is on the complete exclusion of air that the preservative power, in the processes before stated, and in those of M. Appert, essentially depends; but this power is greatly assisted by the action of high degrees of heat. In our remarks on the theory of these processes, we shall avail ourselves of an excellent memoir on fermentation by M. Gay-Lussac, whose researches were directed to the subject by having himself witnessed the success of M. Appert's methods.

We have already dwelt on the importance of excluding air in these processes; and its particular necessity is well evinced by the following experiments of M. Gay-Lussac. He took a bottle of the must (expressed juice) of the grape, which had already been preserved more than a year by M. Appert's method, and was still perfectly limpid; he decanted this juice into another bottle, which was then closely corked, and placed in a temperature varying from 60° to 86° Fahrenheit. In eight days after, it had lost its transparency, fermented, and was changed into a vinous liquor, foaming like the best champagne. A similar bottle of juice that had not been thus opened and exposed to the contact of air, although placed in the same circumstances, exhibited no sign of fermentation. He next passed a portion of juice into a vessel filled with and inverted over mercury, and added to it a small quantity of oxygen gas; and another portion of juice he confined in a similar vessel, perfectly freed from air. The former portion fermented in a few days; but the latter gave no sign of fermentation even at the end of forty days. Similar results were obtained in experiments on the preserved juices of gooseberries; and he found the same thing to hold with regard even to recent juice. He passed some entire grapes into a vessel over mercury, and added to them hydrogen gas repeatedly, with the design of removing all atmospheric air. The fruit was then broken down by passing a wire into the jar, and the vessel was left in a temperature of from 59° to 68° of Fahrenheit. At the end of twenty-five days it exhibited no sign of fermentation; but this process commenced the same day in juice to which a little oxygen gas had been added; and was also rapidly
excited in the former portion when a little of that gas was supplied. This action of oxygen gas, in exciting fermentation in vegetable juices, is equally displayed in its operation on animal substances. M. Gay-Lussac prepared, after the method of M. Appert, bottles containing beef, mutton and fish, which kept perfectly good as long as the air was excluded; but when exposed to its influence, they entered promptly into putrefaction, like fresh animal matter. By analyzing the air contained in the bottles with preserved animal and vegetable substances, he found that it did not contain a particle of oxygen gas: and the absence of that gas is consequently, says he, a condition necessary to the preservation of animal and vegetable substances.

But though the complete exclusion of the oxygenous portion of the air seems thus effectually to prevent fermentation and putrefaction, yet this is a circumstance which it is always difficult, and sometimes impossible, to accomplish: and many of the facts just recited, show how small a portion of that gas, even its temporary contact with a vegetable juice, is sufficient to excite fermentation. To remedy this inconvenience seems to be the purpose of submitting the substances, previously placed in closed vessels, to the operation of a boiling heat. By this operation some change is induced which indisposes them to enter into that chemical action by which their properties are destroyed: and it also contributes to remove or destroy any small portion of oxygen gas that may be mingled with or adhering to them. This power of heat to arrest fermentation and putrefaction, is well shown in the experiments of the ingenious chemist before mentioned. He found, that the fermentation which, by exposure to the air, had actually commenced in grape-juice, was at once stopped if the bottle containing it was immersed in boiling water. So striking is this effect of a high temperature, that, if its application be repeated within certain intervals, neither fermentation nor putrefaction takes place in bodies, even though they are exposed to the air. He took portions of gooseberry-juice, cow's-milk, and a solution of gelatine, and exposed them, at first every day, and afterwards every other day, to the boiling temperature of a water-bath, saturated with salt to augment its heating power. At the distance of two months, all these substances were perfectly preserved; while similar portions of the same fluids, exposed to the air, but not thus heated, went through the usual stages of fermentation and putrefaction. In like manner, if vessels containing solid animal substances, after having been opened and exposed to the air, were again closed and submitted to a boiling temperature, the preservation of their contents was prolonged: but if the vessels had been badly closed—if the heat was not continued a sufficient time—or if all the oxygen gas contained in the vessels was not destroyed, then putrefaction did not fail to take place. These facts prove, that heat performs a very important part in the preservative process; and that it acts by producing some change in the animal and vegetable substances exposed to it, which counteracts the natural tendency in those substances to fermentation and putrefaction. It must also speedily produce the removal or change of the small portion of oxygen gas which the vessels may contain: and as the operation of this heat is continued after that change is effected, no injurious consequence seems to arise from the introduction of that small portion of gas. We are thus furnished with satisfactory reasons for each stage of the process we have been considering, and find that they both contribute to one and the
same end;—that the heat acts by indisposing the substances from entering into chemical action, and by removing all risk of ill effect from the small portion of air which the vessels may contain—while the rigorous exclusion of the external air contributes to render permanent the state into which the substances have been brought by the temporary application of heat.

Other questions, connected intimately with the theories of fermentation and putrefaction, arise out of the foregoing facts. In what manner does a boiling temperature act on vegetable and animal substances, so as thus to enable them to resist that tendency to chemical change which they manifest, in ordinary circumstances, when they are exposed to the air?—and what changes does the air itself undergo, or what effects does it produce in these substances, which render it so important, if not essential, an agent in fermentation?—Dark and difficult as the subject may be, we are tempted to prosecute it a little farther; and, guided by some facts and analogies supplied by Gay-Lussac and others, and some ideas on these subjects over which we have occasionally brooded, to hazard a few speculations, which, even if remote from the whole truth, may still approach nearer to it than, on a first view, many may be willing to believe.

Chemists have ascertained, that the presence of a substance called gluten, and which forms the material part of yeast, is essential to the process of fermentation in vegetable fluids: but this gluten, though it exist in the juice of the entire grape, and in the preserved juice of that grape, does not excite fermentation, unless, as Gay-Lussac has shown, it come into contact with the air: neither, on the other hand, does the air excite this action in a vegetable fluid that is wholly deprived of gluten: so that the concurrence of gluten and of air seems necessary to the constitution of a proper ferment. By the operation of a boiling heat, this gluten appears to suffer a degree of coagulation or concretion: for Gay-Lussac remarks, that a slight deposition of a substance of an animal nature is formed in a vegetable juice, previously limpid, by the action of a boiling heat; and that this juice is then incapable of fermentation, nor does the deposited matter act as a ferment to other bodies. Even yeast of beer, he adds, loses its properties as a ferment, after having been exposed to a boiling heat. We may, therefore, infer, that a boiling temperature produces a chemical change on gluten, as it does on albumen, by which it is rendered soluble, and is in that state incapable of entering into those changes which constitute fermentation: Consequently, a boiling heat, by thus acting on gluten, removes an essential condition of change, and therefore contributes to the preservation of the substances to which it is applied.

With respect to the air, it appears also, from the experiments of Gay-Lussac, to be absolutely necessary to the commencement of fermentation, both in the recent and preserved juices of fruits, which already contain gluten,—but to which no proper ferment has been added. It is only, however, the purer part of the air, what is called its oxygen gas, that is required, and that undergoes change. Chemists have long been aware, that, in this process, oxygen gas was changed into carbonic acid; but, in general, they have not attempted to ascertain the extent to which this change takes place. As far as we know. M. De Saussure is the only chemist who has directed his attention to this particular object:—and has shown, by experiment, that when fruits, and other parts of vegetables, are confined in atmospheric air, they convert its oxygen into an equal bulk of carbonic acid gas. In the
APPERTIZING

same way, white wine, says he, is changed into vinegar, by being placed in contact with oxygen gas, but without diminishing the volume of air: and the carbonic acid produced, is precisely equal to that of the oxygen which disappears. In most instances, the production of this acid greatly exceeds that of the oxygen lost: and, when fermentation is actively going on, it is abundantly produced without even the presence of that gas: but this acid gas, as Saussure observes, then draws its two elements from the fermenting vegetable, while in the former case it derives only the carbon from the substance in fermentation. In both cases, carbonic acid seems to be a product and consequence of chemical change, and not a cause of the fermentation that yields it: for it is oxygen gas that is employed in the first stage of the process, and to its conversion into carbonic acid, the excitement of fermentation and the production of more carbonic acid succeeds.

But although oxygen gas be thus necessary to the commencement of fermentation, yet since, according to the experiments of De Saussure, all its oxygen exists in the form of carbonic acid gas, it follows, that none can be held to combine with the gluten or any other ingredient of the vegetable substance. Indeed, when we see how small a quantity of air seems sufficient to excite fermentation in bodies disposed to that action, it seems unreasonable to think, from what we know of other combinations of that element with bodies, that a quantity altogether so evanescent, should be able to excite such active changes in such large masses of matter. If, therefore, neither the oxygen that disappears, nor the carbonic gas that is formed, can be deemed the active principle or cause of fermentation, nothing else remains, as far as the air is concerned, but to attribute it to the operation of the subtile matter that is liberated when the transition of the oxygen gas into carbonic acid takes place. This caloric matter, seems either to form some union with gluten, or to produce in it some change which constitutes it a proper ferment. When, in this way, a ferment is formed, and the fluid in which it resides is placed in favourable circumstances, the process of fermentation begins, and is continued afterwards without the farther necessity of air. Hence it is, that fermentation takes place in liquors formed only of sugar and water, to which yeast (which is itself a product of fermentation) has been added, even without the concurrence of air. But it does not occur in the expressed juices of fruits, which yet contain abundance of gluten, if they have never come into contact with air. To the constitution of a ferment, therefore, gluten or some similar substance is necessary: but that gluten must receive its activity from the subtile matter liberated by the decomposition of the air. When this property is communicated, the ferment produced acts on inanimate bodies, like morbific poisons on the living system; and propagates and multiplies itself by its own action, independently of the source from which it primarily derived its activity.

But if the subtile matter, liberated by the decomposition of the air, be thus deemed the active principle of a ferment, one might conceive, that other agents of a similar nature, should be able to excite fermentation in a fermentescible fluid that had never been exposed to the air. Accordingly, Gay-Lussac asserts, that fermentation may be excited in the juice of the grape, obtained without the contact of air, by plunging into it the two wires of the galvanic pile.

There is every reason to believe, not only from analogy, but from actual
experiment, that the air acts precisely in the same manner in occasioning putrefaction in animal substances; for the oxygenous portion alone disappears, and its place is supplied by an equal bulk of carbonic acid gas. The calorific matter liberated during this change, acts, probably, on the gelatinous or albuminous ingredients of these animal compounds, in a manner somewhat similar to its action on the gluten of vegetables; and a fermentation, which ends in decomposition, is excited. Hence the exclusion of air is equally necessary in the preservation of these substances; and the effect of a boiling heat in retarding putrefaction, is perhaps to be ascribed to its action on the albuminous matter of the animal substance, by which it is enabled to resist the usual tendency to decomposition.

But whatever fate may attend these theoretical speculations, we are not without hope that some benefit may accrue to the public from attention to many of the facts and suggestions which have now passed under our review. How much good liquor, for example, might be annually saved from becoming vinegar, by the simple expedient of attending more strictly to the qualities of the cork, and the method of corksing, so as effectually to exclude the air; and even how much of this vinegar itself might be preserved from putrefaction, by the scarcely less simple means of immersing it, for a short time, in boiling water! As we profess to hold gourmandise in due horror, we shall say nothing of the advantage of having grouse, woodcock, ortolan, salmon, mullet and turbot, at all seasons, and in spite of climate or game laws—But what convenience would it not afford to every family, living at a distance from markets, to be able, by the methods here recommended, to provide themselves with rich and fresh animal food at all seasons; and which should require no other preparation for the table than merely heating it over the fire? Stores of food might thus be laid in, when provisions were cheap, which would furnish substantial and savoury nourishment at times when prices might be high, or the articles themselves could not be easily procured. Where putrefaction might be likely to come on before the stock of provisions could be consumed, how much of it might be preserved in a wholesome state for future use by the methods of M. Appert! What ready supplies of broth, and of other nutritious and palatable substances would they not present, at all times, to the palled and capricious appetites of the sick!—And their importance to the mariner in those times and places which convert common necessaries into real luxuries of life, has been already noticed. In the preservation of vegetables, generally, all who inhabit such cold and sluggish climates as ours, may derive great benefit and high gratification from the adoption of many of the suggestions herein conveyed. The art of the preserver may be made to anticipate that of the gardener; and when our trees are still destitute of foliage, and our fields clad in snow, we may partake of the most perishable delicacies, and have a foretaste of the luxuries of spring.

We had designed to consider those other methods of preserving animal and vegetable substances which we have denominated artificial, and which consist in mingling with the substance to be preserved, some other matter, which shall retard or prevent fermentation and putrefaction. Such an examination would have brought under our notice many interesting, though familiar facts, and might, perhaps, have suggested some practical applications: but the present state of chemistry would not, we fear, have afforded any great aid in the way of explanation. Some other means, both of pro-
moting and preventing fermentation and putrefaction, and even of removing, to a certain degree, the pernicious effects of the latter, when it may have come on, entered also into our first design; and various illustrations of the modes in which the decay and decomposition of organized matter is accomplished or prevented, in different situations and circumstances, might probably have been drawn from many existing natural phenomena, and many practices in the useful arts: But the unexpected length to which our observations have already extended, the difficulty of collecting and comparing the scattered materials of such an inquiry, and the little prospect of arriving at any very satisfactory termination of the labour, have, together, contributed to arrest our progress. In the meanwhile, we have satisfaction in thinking that the branch of the subject, now brought under the notice of our readers, however imperfectly treated by us, is, nevertheless, not only the most important in itself, but that which can best be explained and understood, and may be most easily, cheaply and extensively adopted in practice. It is that also which alters and impairs, in the smallest degree, the natural properties of the substances employed; and, in all its applications, makes addition to the wholesome luxuries and substantial comforts of life.

LOUIS PASTEUR

The French savant who demonstrated the relation of micro-organisms to decomposition, thus making progress possible along accepted scientific lines in food conservation.
THE ART
OF
PRESERVING
ALL KINDS OF
Animal and Vegetable Substances
FOR
SEVERAL YEARS.

BY M. APPERT.
A WORK PUBLISHED BY ORDER OF THE FRENCH MINISTERS OF THE
INTERIOR, ON THE REPORT OF THE BOARD OF
ARTS AND MANUFACTURES.

TRANSLATED FROM THE FRENCH.

FROM THE SECOND LONDON EDITION OF 1812

NEW-YORK:
PUBLISHED BY D. LONGWORTH,
SHAKESPEARE GALLERY.
1812.
Gaseous Fermentation in the Canning Industry

H. L. Russell*

In the canning industry more or less trouble is occasioned by the after fermentation of the prepared material. A small per cent of the product usually spoils and although this amount is subject to some variation, yet a certain proportion of the crop is invariably wasted. This series of after fermentations vary with different vegetables, but the trouble is usually expressed by a bulging of the can some time after it is packed. These spoiled cans that are technically known as “swells” are filled with gas and are absolutely worthless. Occasionally the percentage of “swells” is greater than common, thus causing losses of considerable magnitude.

During the past season this Station was appealed to by a leading canner for assistance in regard to a serious trouble of the above nature. For some unknown reason, the number of swells was very much increased so that the loss in the manufactured product was very great. Previous to this abnormal experience, no trouble had been had at this factory or at others where the same system of “processing” was used. A biological examination of the canned material (in this instance peas) of both sound and doubtful quality showed that the spoiled goods were invariably in an advanced stage of fermentation and filled with bacteria. One of the forms isolated proved to be an organism capable of fermenting sugar solutions with a copious evolution of gas.

That this organism itself was sufficient to produce the gaseous changes was demonstrated by the following experiment: Several cans of presumably good peas were selected and placed in an incubator in order to test their keeping quality. They were kept under these conditions at 90° F. for several days, and as no change took place, they were considered as sterile. To thoroughly prove this, cans were opened and cultures made from their contents but always with negative results. A tested can was then selected, and after carefully sterilizing the surface in a direct flame, a minute opening was made and the contents of the can inoculated with a tiny fragment of a pure culture of the gas producing bacillus noted above. The opening was then immediately soldered and the can kept at room temperature. Thirty-six hours thereafter, it began to show signs of swelling that continued to be intensified until the tin cover showed by the strain that it was on the point of breaking. When punctured, the gas escaped with such force as to blow out a considerable quantity of the liquid. Cultures made from the same showed that the gas germ was the only one present. Further study of this germ indicated that it was one of those forms able to live either in the presence of or without free oxygen. This class of germs is greatly to be feared in the canning industries, for even after the cans are sealed and the air excluded, the conditions are not un-

* Russell, Dr. H(arry) L(uman), University of Wisconsin, Madison, Wis. Poynette, Wis., March 12, 1866, B.S. Wisconsin, 88; M.S., 90; Hon. Sc.D., 96; Berlin, 90; Pasteur Institute, Paris, and Naples Zoological Sta., 90-94; Ph.D., Hopkins, 92; Asst. Prof. bacteriology, Wisconsin, 93-96; Prof. 96-97; bacteriologist, Exp. Sta., 93-97; director 07-30; director alumni research foundation, 30. Author of numerous bulletins and papers upon bacteriology and particularly as applied to the dairy industry.
favorable for the development of any germs that may be able to withstand the details of the canning process.

Having determined the cause of the trouble, the attempt was then made to discover at what stage the undesirable bacteria gained access to the peas so that intelligent measures might be directed against the proper source. In this connection, it will be necessary to give briefly the salient steps in canning the product. They are as follows:

1. Shelling the peas in an automatic apparatus.
2. Grading through a series of sieves to select material uniform in size.
3. Blanching. The pea is immersed in boiling water for one to two minutes, then immediately cooled.
4. Filling the cans.
5. Adding the liquor. The cans are then filled with a solution of salt and with those peas that are deficient in sugar, a quantity of this substance is also added.
6. Hermetically sealing the cans.
7. Cooking in a tightly closed steam cooker. This process prepares the pea for the table.

The cooking is done in large closed kettles capable of holding about 1,000 cans. In this closed receptacle, the steam pressure can be raised to any desired point and with this increased pressure, a rapid rise in temperature takes place. The time of cooking and also the temperature at which it is done varies from one operation to another depending upon the character of the pea. Usually this treatment did not extend beyond 30 minutes at a pressure of about 10 lbs. of steam, thus producing a temperature of about 232° F.

It will be noted that there are two cooking operations. The first of these, however, would have but little effect on killing bacterial life in a latent condition as it is not continued for a sufficient length of time. If bacteria are present on the raw material (and they must inevitably be as a result of the shelling process), the only efficient agent in destroying them would be the final cooking. This would also be true from whatever source the infection came.

In going over the records of the previous year, it was found that most of the trouble occurred in lots that were put up on days where the length of the cooking time had been materially diminished. In the attempt to shorten the time of cooking so as to leave the liquor as clear as possible, it had doubtless been reduced to a point below that at which the gas germ was killed in a latent stage. As the canned stock was then insufficiently sterilized, active fermentation took place as a result of the bacterial development.

With some varieties of peas, it is impossible to expose them to a boiling temperature for a considerable time as the skin of the pea is cracked and the mealy part renders the liquor turbid. An attempt was made, however, to secure the desired result, not by increasing the length of exposure but by using a greater steam pressure and consequently a much higher temperature. The factors of time and temperature in sterilization of any material have an inverse relation to each other. The same end may be attained by increasing the temperature and diminishing the time as is done where the time is lengthened and the temperature lowered.
While the procedure was predicted as fatal to bacterial life, it was not known what effect it would have on the quality of the canned product. An experiment of cooking a few cans under a steam pressure of 18 pounds, at a temperature of over 250° F. was made. The cans were opened after this process and the liquor was found to be clear and the pea intact. Having found that this treatment would not injure the quality of the peas so far as could be determined at this time, the experiment was repeated under the author's direction on a much larger scale, in order to test the keeping quality of the product.

The canning details and results as to keeping quality are given in an appended table, together with similar details as carried out in the “processing” of the same kind of peas according to the usual method that was done on the day preceding the above experiment.

Canning details with peas naturally rich in sugar:

<table>
<thead>
<tr>
<th></th>
<th>Usual Process</th>
<th>Experimental Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam pressure in cooking</td>
<td>10 lbs.</td>
<td>15 lbs.</td>
</tr>
<tr>
<td>Temperature</td>
<td>232° F.</td>
<td>242° F.</td>
</tr>
<tr>
<td>Time</td>
<td>26 Min.</td>
<td>28 Min.</td>
</tr>
<tr>
<td>Number cans “processed”</td>
<td>6,175 cans</td>
<td>11,859 cans</td>
</tr>
<tr>
<td>Number cans “swells”</td>
<td>306 cans</td>
<td>8 cans</td>
</tr>
<tr>
<td>Per cent of “swells”</td>
<td>Nearly 5%</td>
<td>Practically None</td>
</tr>
</tbody>
</table>

Canning details with peas naturally deficient in sugar:

<table>
<thead>
<tr>
<th></th>
<th>Usual Process</th>
<th>Experimental Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam pressure in cooking</td>
<td>11 lbs.</td>
<td>15 lbs.</td>
</tr>
<tr>
<td>Temperature</td>
<td>234° F.</td>
<td>242° F.</td>
</tr>
<tr>
<td>Time</td>
<td>17 Min.</td>
<td>30 Min.</td>
</tr>
<tr>
<td>Number cans “processed”</td>
<td>4,607 cans</td>
<td>2,520 cans</td>
</tr>
<tr>
<td>Number cans “swells”</td>
<td>135 cans</td>
<td>14 cans</td>
</tr>
<tr>
<td>Per cent of “swells”</td>
<td>About 3%</td>
<td>About ½ Per Cent</td>
</tr>
</tbody>
</table>

The results of this experiment were highly gratifying as it resulted in a material diminution in the amount of the spoiled product. In the above experiment, the number of “swells” under the old process was not far from normal, but even this relatively low percentage was greatly diminished by the more stringent sterilizing treatment. It is to be confidently expected that a repetition of the former disastrous losses could be almost entirely prevented by the application of increased pressure without necessarily lengthening the time of exposure.
INVESTIGATIONS BY PRESCOTT AND UNDERWOOD

The canners of this country owe more to Prescott and Underwood for placing their industry upon a scientific basis than to any other investigators. Their work covered a period of about ten years dealing with the fundamental principles of bacteriology and their application to factory operations. The results of their work were presented to many groups but the three papers which follow were epoch-making in changing an industry based upon individual experience to one under scientific control.


Micro-organisms and Sterilizing Processes in the Canning Industry

By Samuel C. Prescott and W. Lyman Underwood
Read October 8, 1896

The process of hermetically sealing food materials in jars or cans and their subsequent sterilization by heat has become an enormous and most important industry. From a sanitary point of view, canned foods are of the highest value, because if properly prepared they are free from all bacteria. The enormous use of these goods testifies to the high regard with which they are held, and sanitarians cannot fail to view this fact with satisfaction.

The magnitude of the canning industry at present may be indicated by figures showing the number of cans packed annually, in the United States alone, of some of the larger branches.

Sardines, 80,000,000 cans
Salmon, 96,000,000 cans
Oysters (in Baltimore alone), 1,250,000 bushels
Corn, 72,000,000 cans
Tomatoes, 120,000,000 cans

Besides these are packed very extensively, lobsters, clams, meats, soups, peas, beans, and fruits.

It occasionally happens that deterioration or loss of some food materials so prepared may result if the sterilization, or as it is known to the trade, "processing," is not conducted in a thorough and scientific manner. This trouble is not confined to any one class of foods, but may be encountered in vegetables, meats, fish, oysters, clams, and lobsters, although it is a notable fact that spiced goods usually keep indefinitely.

At the suggestion and under the supervision of Professor Sedgwick we have made a careful experimental study of one branch of the industry, viz., the packing of clams and lobsters.

It is generally believed that the canning industry was originated by Nicholas Appert,* a Frenchman, who in 1810 preserved fruit by heating and hermetically sealing in glass jars. Probably the first to adopt these methods in America was William Underwood, an Englishman, who in 1821 began in Boston to preserve foods according to Appert’s methods. These methods of Appert were followed until about 1840, when glass jars were largely displaced by tin cans. This substitution, it is believed, originated a year or two before with Charles Mitchell, a Scotchman, who packed corn and lobsters in tin cans near Eastport, Maine.

The advent of tin cans caused the first great stride in the business, as it opened a large field for work in the preservation of meat, vegetables, and fish. Salmon was probably first packed at St. Johns, N. B., in 1839, and shipped directly to the Pacific Coast, while at present salmon packing is confined to the Pacific States. About the same time oysters shipped in barrels from Baltimore were packed in Boston. Everything in connection with the process was kept as secret as possible, therefore only a few firms were enabled to engage in the business, but gradually through em-

ployees the process became more public. During the war the trade was
given a tremendous impetus through the government’s requiring canned
food supplies for the army, and since the war the growth of the industry
has been constant and steady.

With the increased demand for canned goods came also the necessity
for better methods. The old method of procedure in packing fish was as
follows: After packing and sealing, the cans were heated for an hour in
boiling water, then taken out and “tapped” or vented in order to expel air
and produce a vacuum. Sealed again and boiled for an hour and a half,
again tapped and sealed and given a final boiling of three hours. Thus the
total time of heating was five and one-half hours, and in many cases even
more time was given.

It was formerly believed that the vacuum was the principal factor in
keeping the goods, a belief still clung to by many packers. The vacuum,
although unnecessary for sterilization, is necessary for inspection. Before
the cans are put on the market each one is thoroughly examined to detect
any unsoundness, or what is known to the trade as “swells.” This exami¬
nation consists of inspection and sounding the cans after “processing,”
t.e., sterilization. Sound cans should show a vacuum, as indicated by con¬
cavity of the ends, and should emit a peculiar note when struck. On the
other hand, unsound cans which have not yet swelled give a characteristic
dull tone when struck. By the difference in the quality of the tones a
skilled inspector can instantly distinguish between sound and unsound
cans. Any cans not showing a vacuum are rejected, the annual loss result¬
ing from this source being very large. After inspection the cans are gen¬
erally put in stacks, and before leaving the packer are again examined.
It sometimes happens, however, that spoiling without swelling occurs.
For the detection of such cases, special methods must be employed. Such
cases are sometimes found in canned clams, and more frequently in lob¬
ster, in the latter case being known to the trade as “black lobster.”

Since long continued heating tends to disintegrate and darken the foods
which it is desired to preserve as fresh as possible, it has always been the
aim of packers to reduce the bath time as much as possible. Consequently
there has been a gradual shortening of the time of heating in the water
bath, until at present the average treatment by this method is from two
and one-half to three hours, divided into two periods.

In 1863 a “chemical bath,” consisting of calcium chloride, was intro¬
duced to some extent. Owing to the large amount of the salt in solution
and its consequent high boiling point, a temperature of 250° F. could be
easily obtained. With this temperature the time of heating could be greatly
lessened, and at the same time sterilization was assured. In one form of
this process a lozenge of sodium sulphite was fastened on the under side
of the cover of each can by means of fusible metal. The object of this was
“to decompose the air remaining in the can.” This method of procedure
was found to be impracticable, owing to the frequent explosions of the
cans. This bath was in use but a short time, being followed by a return to
the earlier methods.

The introduction of digesters or “retorts,” about 1870, was the next and
most recent step in the development of sterilizing apparatus. By their use
an actual temperature of 250° F. (127° C.) may be easily obtained both
inside and outside the can; so explosions are avoided. The corresponding
pressure is fourteen pounds. The only precaution required is to reduce the temperature and pressure cautiously. They have not been accepted as entirely satisfactory, however, on account of the darkening of the goods caused by long continued heating. It is probable that retorts are now used less than formerly in some quarters, through ignorance of their effectiveness, yet it is well known that many packers are using them with excellent results.

**Examination of Swelled Cans, and Descriptions of the Bacteria Found**

As has been stated above, all cans before they are put upon the market are carefully tested for imperfections, and any showing leakage or swelling are rejected, and the annual loss from these sources is very heavy. Our investigations began with a careful examination of a large number of spoiled clams and lobster. The contents of such cans were found to be badly decomposed, in some cases almost entirely liquefied, much darkened in color, and of a very disagreeable odor. Bacterial examination showed that in every case where spoiling had occurred, living bacteria were present in great numbers. In sound cans, on the other hand, no living bacteria could be detected, and the contents proved to be sterile. As would be supposed in the present state of bacteriology, there is no reason to doubt that swelling and decomposition are invariably the result of bacterial action. In some cases a can contained a culture apparently pure, while other cans might contain a mixture of several species.

The ordinary bacteriological methods, with some modifications, served for the separation of these organisms into distinct species, and made possible their cultivation in pure cultures in artificial media. Of the nine species of bacteria obtained, two are micrococcii, while the other seven are classed among the bacilli. All of them are noticeably rapid in their development in an incubator at blood heat (98° F., 37½° C.) both in liquid and on solid media, while they grow slowly at a temperature of 70° F. (20° C.). They may be readily stained by the usual staining reagents. In several of the forms endospore formation has been observed, and these forms are likewise noticeable for the rapidity with which such sporulation occurs. The following detailed descriptions will show some of the characteristics of these species:

**Bacillus No. 1**

**General Characters**

*Shape and arrangement:* Long rods with rounded ends occurring singly, and in chains of varying lengths. Often shows a gelatinous sheath when grown in liquid culture.

*Size:* 4–7μ x 1.5μ.

*Motility:* Moves with serpentine motion.

*Spore formation:* Large oval centrally located spores. Develop with ease.

*Relation to temperature:* Grows at both 20° and 37½°, but better at latter temperature.

*Relation to air:* Aerobe and facultative anaerobe.

*Relation to gelatine:* Liquefies readily.

*Color:* Creamy white.

**Gelatin**

*Stick culture:* Growth extends throughout line of puncture. The gelatin is liquefied, forming a broad trumpet-shaped liquid portion, at the bottom of which is a small amount of flocculent precipitate. Film formed on surface, which breaks up and settles, leaving a layer of clear liquid at top. Entirely liquid after three weeks.
Plate culture: Surface colonies: First appear as small white dots. Liquefaction sets in at once, first appearing as a clear ring of liquid gelatin surrounding the colony. Under low power there is seen a dark granular center, and an outer ring of paler threads interwoven and forming a thin, irregularly circular zone. Floculent ppt. at bottom of the saucer-shaped depression caused by each colony.

Agar
Streak culture: A moist, creamy white, smooth, shiny growth covering nearly the whole surface of the agar. Edges appear granular or "frosty".
Plate culture: Surface colonies: First develop as circular shiny colonies with sharp outline. An irregular film is soon formed which extends out on all sides, giving an irregular, somewhat branched appearance; dot at center, and faint concentric rings. Submerged colonies small, oval or spherical.

Potato
A gray slimy growth, extending over large part of the surface. This later becomes cheesy and rough on surface. Potato darkened.

Milk
Is coagulated, and later the coagulum is dissolved. Acidity, neutral.

Smith Solution

Nitrate
Is reduced to nitrite but slightly.

Bouillon
Film on surface. Turbid. Heavy sediment of flaky nature.

BACILLUS No. 2

General Characters
Shape and arrangement: Short rods, occurring singly and in chains of 3-6 elements.
Size: 1.5-1.8μ x .6μ.
Motility: Motile.
Spore formation: Not observed.
Relation to temperature: Develops rapidly at 371/2° C., more slowly at 20°.
Relation to air: Aerobe and facultative anaerobe.
Relation to gelatine: Does not liquefy.
Color: Pale color.

Gelatin
Stick culture: No growth visible until after second day. On fifth day hazy growth is shown all along the line of inoculation. Mass of small rounded colonies on surface.
Plate culture: Surface colonies: First appear as circular shining droplets almost transparent. After two weeks colonies are 1/8" in diameter, elevated, rough, with a dot at center, and irregularly concentric rings. Edge of colony crenated or roughly scalloped. Submerged colonies: Very small, circular and brownish in color.

Agar
Streak culture: On second day surface is covered with a thin, rough, pale yellow, shiny layer.
Plate culture: Surface colonies: Circular grayish white colonies somewhat elevated, and sometimes slightly scalloped at edges. Surface rather dull. Dot at center under microscope appears to be shaped like red blood corpuscles, thinner at center than at rim. Submerged colonies: Very small, circular or oval.

Potato
Growth for several days almost invisible. Later a scanty, moist, pale yellow growth, following closely the line of inoculation.

Milk
Is coagulated, forming a solid mass. Strongly acid.

Smith Solution
No gas produced. Turbid throughout. Film on surface. Strongly acid. Considerable sediment.
NITRATE
Is reduced to nitrite with rapidity.

BOUILLON
Paintily turbid on second day. Solution becomes turbid throughout. Film on sur-
face, and heavy flocculent precipitate.

BACILLUS No. 3

GENERAL CHARACTERS
Shape and arrangement: Stout rods with rounded ends occurring singly and in
chains.
Size: 2-3μ x 1.75μ.
Motility: Motion serpentine and rapid.
Spore formation: Oval, centrally located spores 1.8μ x 1.2μ.
Relation to temperature: Growth rapid at 37½°; slower at 20°.
Relation to air: Aerobe and facultative anaerobe.
Relation to gelatine: Liquefies.
Color: White.

GELATIN
Stick culture: Development throughout entire length. Liquefies in trumpet shape.
Thick film on surface, and heavy flocculent precipitate.
Plate culture: Surface colonies. Nearly circular with dot at center, concentric
rings. Liquefaction commences at once, and a veil-like mass collects at the bot-
tom of the liquefied portion. Under low power the edges of the colonies appear
be made of bacteria filaments which extend from the central mass. Sub-
merged colonies very small and spherical.

AGAR
Stick culture: A white, moist, wrinkled growth extending over the whole surface.
Plate culture: Granular, moist, shiny colonies, dark at center, irregular in out-
line; edges thick and rough. Tendency to spread.

POTATO
Dirty white, moist layer spreading over the whole surface. Potato much darkened.

MILK
Is coagulated; coagulum later dissolved.

SMITH SOLUTION
No gas produced. Heavy film on surface and much sediment. Strongly acid.

NITRATE
Not reduced. Film on surface.

BOUILLON
Growth at surface, then a clear layer below, and at bottom a heavy flocculent pre-
cipitate.

BACILLUS No. 4

GENERAL CHARACTERS
Shape and arrangement: Rods with rounded ends, occurring singly or in long
threads arranged side by side.
Size: 3-6μ x 1μ.
Motility: Very motile; darting motion.
Spore formation: Oval centrally located spores 2μ x 1μ are readily formed.
Relation to temperature: Develop rapidly at 37½° C., but slowly at 20°.
Relation to air: Aerobe and facultative anaerobe.
Relation to gelatine: Liquefies readily.
Color: Pale brownish or grayish.

GELATIN
Stick culture: Development quite rapid. Liquefies, giving a liquefied portion hav-
ing shape of an inverted cone. Film on surface, and flocculent material in sus-
pension.
Plate culture: Surface colonies: Small circular white liquefying colonies; under
low power appear irregularly circular, sharply defined and granular. A ring
of liquefied gelatine surrounds each colony almost as soon as the colonies are
visible. Submerged colonies very small; spherical.
Agar

*Streak culture:* Smooth, white, thin layer of dull luster extending all over surface of the agar.

*Plate culture:* Surface colonies: Yellowish white colonies varying in size from small dots to \( \frac{1}{2} \)" in diameter. Nearly circular, dot at center and concentric rings. Submerged colonies: Irregular in shape; very small.

**Potato**

A white pasty, scanty growth at first develops. This later spreads over the whole surface, forming a dry, much wrinkled, brown layer.

**Milk**

Casein coagulated; coagulum dissolved almost completely. Alkaline.

**Smith Solution**

No gas produced. Slightly turbid, heavy sediment. Growth at surface, neutral reaction.

**Nitrate**

Is reduced to nitrite vigorously.

**Bouillon**

Turbid throughout; stringy; tough film on surface, and heavy precipitate in lower third of tube.

**Bacillus No. 5**

**General Characters**

*Shape and arrangement:* Bacilli with rounded ends, occurring singly and in chains.

*Size:* 3–5\( \mu \) long x 1.2–1.5\( \mu \) broad.

*Motility:* Motion serpentine.

*Spore formation:* Not observed.

*Relation to temperature:* Rapid development at 37\( ^\circ \) C., slow at 20\( ^\circ \).

*Relation to air:* Aerobe and facultative anaerobe.

*Relation to gelatin:* Liquefies rapidly.

*Color:* White.

**Gelatin**

*Stick culture:* Growth throughout whole line of inoculation. Liquefaction sets in about third day, forming trumpet-shaped liquefied portion. Film on surface, and flocculent precipitate at lower part of liquefied portion.

*Plate culture:* Surface colonies: White circular colonies which begin to liquefy as soon as they are the size of a pin head, and form depressions or cavities in the gelatine. Under low power they appear to be made up of long interlacing threads which extend from the edge in hair-like processes. Submerged colonies, small, brown, and granular.

**Agar**

*Streak culture:* A pasty thick white growth, rapidly spreading over the whole surface.

*Plate culture:* Surface colonies: Thin spreading colonies often coarsely branched; rather large, granular, and dull in luster.

**Potato**

Watery, white growth, later becoming dry and about the same color as the potato, and extending over a large portion of the surface.

**Milk**

Is coagulated, and coagulum dissolved. Acidity, neutral.

**Smith Solution**

No gas produced. Turbid throughout. Film on surface. Much sediment. Strongly acid.

**Nitrate**

Is reduced to nitrite.

**Bouillon**

Film on surface which breaks up, forming a heavy, flaky sediment.
BACILLUS No. 6

General Characters
Shape and arrangement: Bacilli occurring singly and in short chains.
Size: 1.5μ x 3.5μ.
Motility: Motile.
Spore formation: Not observed.
Relation to temperature: Grows readily at 37½° C., less rapidly at 20° C.
Relation to air: Aerobe and facultative anaerobe.
Relation to gelatin: Liquefies rapidly.
Color: Yellow.

Gelatin
Stick culture: Development begins at surface. Liquefaction quickly sets in, and a trumpet-shaped liquefied portion is formed.
Plate culture: Surface colonies: Yellow, circular, shiny colonies, bluish by transmitted light. Plate is entirely liquefied on fourth or fifth day. The colonies float in the liquefied gelatin, appearing as small yellow spheres.

Agar
Streak culture: A thick, lustrous, moist layer covering the whole surface. Pale orange yellow in color.
Plate culture: Small dome-shaped surface colonies with sharply defined edges. Yellow. Submerged colonies, very small brownish spheres.

Potato
Growth at first thin and watery, and pale yellow in color, later becoming orange yellow, and spreads over the whole surface. Potato is darkened.

Milk

Smith Solution
No gas produced. Solution turbid throughout. Yellow sediment and yellow growth at surface.

Nitrate
Not reduced. Turbid.

Bouillon
Very turbid. Heavy, pale yellow sediment.

BACILLUS No. 7

General Characters
Shape and arrangement: Long slender bacilli with rounded ends, generally occurring singly.
Size: 3–10μ x 1.5μ.
Motility: Motile.
Spore formation: Forms drumstick-shaped spores.
Relation to temperature: Develops rapidly at 37½°, slowly at 20°.
Relation to air: Anaerobe and facultative aerobe.
Relation to gelatin: Non-liquefying.
Color: Yellowish white.

Gelatin
Stick culture: Development is very slight, and growth takes place slowly.
Plate culture: Surface colonies: small, circular, whitish colonies, regular in outline, and sharply defined. Submerged colonies appear as small spherical dots.

Agar
Streak culture: Smooth, lustrous layer covering the whole surface of the agar.
Plate culture: Smooth, circular, rather small white colonies. Outline sharply defined. No characteristic markings. Submerged colonies small, spherical, or oval dots.

Potato
Development very slow and slight. Lumpy growth after several days.

Milk
Not coagulated. Acidity, neutral.
SMITH SOLUTION
   No gas produced. Slightly turbid.

NITRATE
   Not reduced to nitrite.

BOUILLON
   Turbid throughout. Film on surface and sediment.

MICROCOCCUS No. 1

GENERAL CHARACTERS
   Shape and arrangement: Cocci; generally in pairs.
   Size: 1μ in diameter.
   Motility: Motile; in pairs, sometimes rotation about center.
   Spore formation: Not observed.
   Relation to temperature: Rapid development at 37½°. Slow at 20°.
   Relation to air: Aerobe and facultative anaerobe.
   Relation to gelatin: Non-liquefying.
   Color: Yellow.

GELATIN
   Stick culture: Growth first appears at surface. Below surface development is very slow. Yellow growth at surface.
   Plate culture: Surface colonies: Circular with sharply defined edges and yellow color. Under microscope show granular appearance and a deep color at center, surrounded by a paler ring. Submerged colonies show no clear markings, but appear as very small spherical dots.

AGAR
   Streak culture: Smooth, lustrous yellow layer covering much of the surface.
   Plate culture: Small, shiny, pale yellow circular colonies, dome-shaped, and smooth in appearance. Submerged colonies generally oval and brownish.

POTATO
   Development slight, a moist, lumpy growth appearing after several days.

MILK
   Not coagulated. Acidity, neutral.

SMITH SOLUTION
   No gas produced. Slight turbidity. Alkaline reaction.

NITRATE
   Not reduced to nitrite.

BOUILLON
   Turbid throughout; film on surface. Considerable sediment.

MICROCOCCUS No. 2

GENERAL CHARACTERS
   Shape and arrangement: Cocci; occurring sometimes singly, often in groups.
   Size: About 9μ in diameter.
   Motility: Non-motile.
   Spore formation: Not observed.
   Relation to temperature: Develops quickly at 37½° C., more slowly at 20°.
   Relation to air: Aerobe and facultative anaerobe.
   Relation to gelatin: Liquefies slowly.
   Color: Yellow.

GELATIN
   Stick culture: Development chiefly at surface. A yellow film is formed and liquefaction takes place, a cup-shaped depression resulting.
   Plate culture: Small, circular or somewhat irregular colonies, which under low power appear granular; yellow at center, shading into white at the clearly marked edges. They appear bluish by transmitted light. Submerged colonies, spherical or oval, and brownish in color.

AGAR
   Streak culture: Bright yellow, thick, sticky growth, branching and extending over the whole surface.
   Plate culture: Pale yellow, raised, circular, shiny, smooth colonies, generally very small. Submerged colonies, pale, oval, or spherical.
**Potato**

Thin, branching, spreading growth of citron yellow, covering much of the surface of the potato. Later, becomes dry, ridged, and roughened.

**Milk**

Not coagulated. Neutral reaction.

**Smith Solution**

No gas produced. Slight amount of sediment and some turbidity. Alkaline reaction.

**Nitrate**

Not reduced to nitrite.

**Bouillon**

Very turbid throughout. Sediment heavy and viscous.

It is not to be inferred that these include all the species of bacteria which occur in swelled cans even of clams and lobsters. Of those which produce the spoiling of fruits and vegetables, we have as yet slight knowledge.*

**Inoculation Experiments**

If the organisms isolated from decomposing material are the agents by means of which decomposition is effected, it should be possible to reproduce this spoiling at will by inoculation of sterile material with cultures of the organisms in question, external conditions being the same in both cases. To determine this point experimentally, sterile cans have been seeded with pure cultures of bacteria obtained from spoiled cans.

For these experiments cans were tested by incubation at blood heat until it was demonstrated beyond doubt that no swelling would result. The outside of these cans was then sterilized either by passing through a flame or by washing in mercuric chloride. A small hole was then made in the top of the can with a hot awl, the can being held directly in the flame of a Bunsen burner, the operation being carried on in a previously sterilized glass chamber. The bacteria were introduced by means of a platinum needle, and the strictest precautions against contamination were observed. As soon as inoculated the cans were sealed with solder, and, after shaking, were replaced in an incubator at a temperature of 37½° C. (98° F.). A number of similar cans were similarly treated in every way, except that no germs were introduced, the object of this treatment being to show that puncturing the can, thus allowing air to enter, will not cause spoiling if the operation is carried on with due precautions. To illustrate these points more fully a few results are here given:

<table>
<thead>
<tr>
<th>No. of Cans</th>
<th>Treatment</th>
<th>Incubated</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Punched, but not seeded</td>
<td>37½° C.</td>
<td>All kept perfectly</td>
</tr>
<tr>
<td>5</td>
<td>Punched, not seeded</td>
<td>37½° C.</td>
<td>All kept perfectly</td>
</tr>
<tr>
<td>5</td>
<td>Punched, not inoculated</td>
<td>37½° C.</td>
<td>All kept perfectly</td>
</tr>
<tr>
<td>16</td>
<td>Inoculated</td>
<td>37½° C.</td>
<td>14 spoiled</td>
</tr>
<tr>
<td>3</td>
<td>Inoculated</td>
<td>37½° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>12</td>
<td>Inoculated</td>
<td>37½° C.</td>
<td>7 spoiled</td>
</tr>
<tr>
<td>5</td>
<td>Inoculated</td>
<td>37½° C.</td>
<td>All spoiled</td>
</tr>
</tbody>
</table>

The results, as shown above, prove that spoiling is due to the action of the living bacteria in the cans. Moreover, the cans in which spoiling was thus brought about showed, when opened, the blackening and liquefaction characteristic of the original spoiled cans, thus proving that the bacteria isolated were the specific causes of spoiling.

---

* A bacterial study of the spoiling of corn, known to the trade as "sour Corn," has already been begun, and a number of experiments are now in progress.
An investigation was next made of the efficiency of the ordinary water-bath treatment. Sterile cans were seeded, as above described, with germs derived from spoiled cans. After seeding, however, they were subjected to heat in the water bath exactly as is done on a commercial scale, for a length of time varying from two and one-half to four hours. This time was divided into two periods, the cans being tapped between the two heatings. As will be shown by the following figures, quite a large percentage of the cans treated in this manner spoiled:

<table>
<thead>
<tr>
<th>No. of Cans</th>
<th>Time of Heating (Hours)</th>
<th>Incubated</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1+1+1</td>
<td>37½° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>8</td>
<td>1+1½</td>
<td>37½° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>7</td>
<td>1+1½</td>
<td>20° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>8</td>
<td>1+1½</td>
<td>20° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>16</td>
<td>½+½+½</td>
<td>37½° C.</td>
<td>14 spoiled</td>
</tr>
<tr>
<td>8</td>
<td>½+1½</td>
<td>37½° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>3</td>
<td>½+1½</td>
<td>37½° C.</td>
<td>All spoiled</td>
</tr>
<tr>
<td>3</td>
<td>1+1½</td>
<td>37½° C.</td>
<td>2 spoiled</td>
</tr>
</tbody>
</table>

From these figures it is seen that 92 per cent of the cans spoiled, a far greater percentage of loss than occurs in practice. This is to be accounted for chiefly by the fact that in these cans have been planted thousands of bacteria of species which have withstood this temperature in the original spoiled cans, while in the ordinary packing the admission of these bacteria is a matter of chance. Moreover, the temperature at which these cans are incubated appears to be specially advantageous for the rapid development of those organisms which have not been killed by the heat, so the test is unusually severe. It should be distinctly understood that these results do not necessarily signify that a large percentage of the cans receiving water-bath treatment on a commercial scale should spoil if allowed to stand at blood heat, but are valuable because of the practical demonstration that this process is insufficient when such bacteria are present, and is unsafe at all times because of the possibility of such infection.

Bacteriological examination of cans which have spoiled, as described above, has shown in all cases the presence of living germs like those of the species originally put into the cans. Thus for example, the cans inoculated with a culture of a large bacillus have been found to contain pure cultures of a large bacillus corresponding in every way to the one originally inoculated into the can.

Sterilization, or “Processing” Experiments

Our experiments carried on to determine the comparative efficiency of the “dry retort”* and the water bath as agencies of sterilization have, without exception, shown the very great superiority of the former. As indicated above, “processing” in the water bath for two and one-half hours does not always produce complete sterilization. On the other hand, there is no reason to doubt the efficiency of the retort if it be properly used. Of over one hundred cans heated in the retort, but otherwise subjected to the same treatment as the water-bathed cans, not one has swelled or shown any evidence of spoiling even under the severe test of standing in the incubator for a month.

* The term “retort” is a commercial one, and is open to objection, yet is no more so than the term “autoclav” which is used so much in bacteriology, and is applied to the same instrument.
In addition to the water-bath experiments above described, a few tests have been made to show the effect of continuous boiling for various lengths of time upon the bacteria or their spores. Cans inoculated with these bacteria have been subjected to continuous boiling for periods of four, five, six, seven, and eight hours. In these experiments, mixtures of the bacteria were taken for the inoculating material.

<table>
<thead>
<tr>
<th>No. of Cans</th>
<th>Time of boiling (Hours)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>Both spoiled in 48 hours</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>2 spoiled in 48 hours</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1 spoiled in 64 hours</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2 spoiled in 48 hours</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>1 spoiled in 64 hours</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>2 spoiled in 48 hours</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>All spoiled</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>All spoiled</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>All spoiled</td>
</tr>
</tbody>
</table>

These results indicate that the organisms here dealt with have very great resistance to heat—a fact of great interest when taken in connection with the readiness with which spore formation occurs.

For practical as well as for scientific purposes, it is obviously important to determine with accuracy minimal periods of retorting required in the various branches of the industry. We have experimented in this direction with highly satisfactory results, and have found it possible to preserve clams and lobsters with ease, and in a more perfect condition, with absolute certainty, with a much briefer processing period than is ordinarily used, the only essential being the proper control of the temperature. An account of our numerous experiments in this direction is reserved for a second paper.

Biological Laboratory, Massachusetts Institute of Technology, March, 1897.
Sterilizing Processes in the Canning Industries

The Packing of Sweet Corn*

S. C. Prescott and W. L. Underwood

In a paper read before the Society of Arts in October, 1896, we showed the extent of the canning industry in this country and the importance to it of accurate knowledge of the bacteriological principles of sterilization. In that paper we dealt with the packing of clams and lobsters, and described some of the bacteria which are active in the deterioration of these products in case sterilization is not complete. It is interesting to notice that some of the results which we published at that time have since been confirmed by a specialist employed by the Canadian Government to investigate the discoloration of canned lobsters.

We now desire to give an account of our more recent investigations in another branch of the industry, namely, the packing of sweet corn. This art constitutes a very large industry, as is shown by the fact that in 1895 seventy-two million 2-pound cans (72 thousand tons) were packed in the United States.

Historical

The growth of the art has been rapid, for it was not until about 1853 that corn was packed at all with success. Maine has been generally acknowledged as the home of corn packing, and its claim to be so considered is probably just. In 1839 Isaac Winslow began experiments in canning corn at or near Portland. He was for a long time unsuccessful. He first attempted to cook the ears of corn whole, but this proved unsatisfactory on account of their bulk, and it was also thought that the cobs absorbed the sweetness. He next tried to remove the kernels whole by means of a fork, but this was soon abandoned, and the corn was afterward cut from the cob. His first experiments were made in a common household wash boiler, and in a very limited way. Small quantities were treated by various methods, but nearly all the corn spoiled. Some kept, however, and gave promise of ultimate success. In 1843 he built a small copper steam boiler of about two barrels capacity, and carrying ten or twelve pounds of steam. To this he connected wooden tanks lined with zinc and made steam tight. In these crude retorts he “processed” the corn, subjecting it to the direct action of live steam. Nearly the whole lot spoiled, and in consequence of this failure, steam apparatus was abandoned. The next year he returned to open boilers, and continued his experiments with varying success for ten years. In 1853 he applied for a patent, but this was not allowed until 1862.

An abstract of the patent may be of interest: “After a great variety of experiments I have overcome the difficulties of preserving Indian corn in the green state without drying the same, thus retaining the milk and other juices, and the full flavor of the fresh green corn until the latter is desired.

2 Canadian Department of Marine and Fisheries, 29th Annual Report, Supplement No. 2, Ottawa, 1897.
for use. Instead of a hard, insipid, or otherwise unpalatable article, I have finally succeeded in producing an entirely satisfactory article of manufacture, in which my invention consists. I have employed several methods of treatment. My first success was obtained by the following process: The kernels being removed from the cob were immediately packed in cans, and the latter hermetically sealed so as to prevent escape of the natural aroma of the corn, or the evaporation of the milk or other juices of the same. Then I submitted the sealed cans and their contents to boiling or steam heat for about four hours. In this way the milk and other juices of the corn are coagulated as far as may be, boiling thus preventing the putrefaction of these most easily destructible constituents. At the same time the milk is not washed away or diluted, as would be more or less the case if the kernels were mixed with water and then boiled. By this method of cooking green corn the ends of the cans are bulged out, as through putrefaction and the escape of the resultant gases had commenced within the cans. Consequently strong cans are required.

"I recommend the following method: Select a superior quality of the green corn in the green state, and remove the kernels from the cob by means of a curved or gauged knife or other suitable means. Then pack these kernels in cans and hermetically seal the latter so as to prevent the evaporation under heat or the escape of the aroma of the corn. Now expose these cans of corn to steam or boiling heat for about one hour and a half, and then puncture the cans and immediately seal the same while hot, and continue to heat for about two and one-half hours longer. Afterwards the can may be slowly cooled in a room at a temperature of 70° to 100° F."

For nearly twenty years this method was in use, the only change being that the time of processing was shortened. About 1897 retorts were introduced in corn packing, and the second heating was done in them, the time being reduced from two and one-half hours to one. The advent of cookers about 1890 did away with the first heating in the water bath, so that now this is abandoned as an agency of sterilization. Many of the processes formerly carried on by hand are now carried on by machinery. Maine leads in the packing of sweet corn, but large quantities are packed in New York and Maryland and in the West, particularly in Iowa, Illinois and Michigan.

The Souring of Canned Sweet Corn

Sweet corn, when properly prepared, is one of the most valuable of all canned foods, as it retains much of its original flavor, is popular, and is sold at a price within the reach of all. If, however, the sterilizing has not been done thoroughly, there may result fermentation caused by bacteria which have not been killed, producing what is known as "sour" corn. It is not definitely known when sour corn first appeared. In the experiments of Isaac Winslow, spoiling of some kind resulted, but so far as we have been able to ascertain, its nature has never been described. In a Massachusetts factory, however, where corn has been packed with success for nearly twenty years, souring suddenly occurred in 1878. Maine was also somewhat affected at the same period. Until this time corn had been processed for five hours at a boiling temperature with no loss, but in the year just mentioned, with exactly the same treatment, this manufacturer experienced a total loss. Some of this corn was sent to chemists for analysis with
the hope that a remedy might be found at once. It was reported by them
to be due to “fungus consisting of little globules that boiling heat did not
dissolve.”

Early in the following year (1879) the Massachusetts packer who owned
the factory referred to attempted to continue with the old process, but the
corn spoiled. Retorts were procured, and with their higher heat satisfac-
tory results were obtained. For sixteen successive years he experimented
with the old process with the intention of returning to it if possible. The
corn so packed and kept at a temperature of 90 to 100° F., invariably
spoiled, swelling on the third or fourth day. It was thought that the trou-
ble might be local, and to decide this he visited different sections, carefully
selected and gathered corn, and, returning at once to his factory, packed it
in the old way with the least possible delay, working sometimes all night
that this might be done. The results were always the same—the corn could
not be successfully packed by the old method. Had any locality been found
where this could have been done, he intended to remove his factory to that
neighborhood.

The exact chemical changes which take place when sour corn is produced
are difficult to state, and vary under different conditions. The sugar and
starch in the corn are fermented for the most part to lactic, acetic, and
butyric acid, thus giving rise to the souring. There are also other products
of decomposition. Gases are frequently evolved, but being dissolved by
the liquid in the can at the ordinary temperature, in the majority of cases no
swelling results.

The loss resulting from sour corn during the last eight or ten years has
been enormous, in some years being much more than in others. Thousands
dollars have been lost in a single year by individual manufacturers who
have experienced this trouble. Moreover, the uncertainty and the possi-
bility that losses may be incurred are constant sources of worry and un-
easiness to those engaged in this industry.

Detection of Spoiled Cans

Spoiling in canned goods is generally indicated by bulging of the ends
of the cans, caused by the pressure of the gases produced within. Thus a
packer may generally detect any unsoundness before the goods are put
upon the market, as all are overhauled and inspected before ultimate ship-
ment. In the case of sour corn, however, at least in its first stages of de-
terioration, there is no outward indication of trouble. It is only under
rather exceptional conditions that swelling occurs. If the temperature and
other conditions are favorable for the rapid development of germs which
can produce fermentation with the formation of gas, swelling will result.
Since, however, the latter conditions rarely prevail in the factories, the de-
tection of sour corn becomes difficult. Corn which is sweet when shipped
may become sour many months afterwards. To illustrate this fact an
instance may be cited where from the same day’s packing two lots of corn
were shipped, one to the northern and one to the southern part of the
United States. That which was sent to the North was in perfect condi-
tion at the end of the year, while that which went to the warmer climate
became sour in a short time. Many instances of the same nature have been
noticed by different packers, and similar results may be obtained by labo-
ratory experiments. The explanation of this fact probably is that all the bacteria were not killed by the heating to which these cans were subjected, and that the conditions for growth of the micro-organisms became favorable only in the warmer locality. Provided sterilization is not complete, there seems little reason to doubt that climatic condition is a most important factor in the souring of corn. It should always be borne in mind that if processing or sterilization is complete sour corn cannot result, because the germs of fermentation are destroyed. When souring occurs the percentage of bad cans may be small, but often runs from 10 to 40 per cent, or even higher. Such goods are generally returned, and an attempt is made to separate the sweet from the sour cans. To do this there are two methods in common use.

According to the first method, the cans are put into a tank of water at a temperature of 80° F., where they stand for from six to twelve hours in order that the contents may be heated uniformly throughout. They are then removed and their ends just submerged in water at 190° F. Here they remain for not more than thirteen minutes. At the end of that time those cans which are swelled are rejected as sour. The other method is to boil the cans for one hour. This causes all the ends to bulge. They are then cooled, and those whose ends remain bulged for more than eight hours are rejected, while those which “snap back” within this time are considered satisfactory. Both these methods depend for their success upon the fact that at certain temperatures gas is produced rapidly by bacteria within the cans.

**Bacteriology of Sour Corn**

Our investigations commenced in February, 1897, with the examination of a large number of cans of sour corn. On opening the cans no change was noticeable to the eye, the corn appearing fresh and of a natural color. In some cases a sour odor could be detected, but in others this was not observed. It was to the taste that the trouble was most apparent, the corn being sour and of a peculiar astringent quality. Bacteriological examination showed sound cans to be sterile, while spoiled cans invariably gave evidence of bacterial action. Pure cultures of twelve species of bacteria were obtained, of which eleven were bacilli, and one was a micrococcus. It must not be supposed that these bacteria are disease-producing; they probably act merely upon the saccharine and starchy matter, transforming it to organic acids and other substances of more or less disagreeable taste and odor, and make the corn unpalatable and destroy its commercial value.

By inoculating sterile cans of corn with these organisms we have been able to produce souring in all respects similar to that of the spoiled cans from which they were originally taken. Our experiments were conducted in the laboratory in the following manner: A number of cans were selected and all of them were punctured, this operation being done in a sterile glass chamber. A part of the cans were inoculated with cultures obtained from sour corn, and all the cans were then sealed and put in an incubator kept at the blood heat. The cans which had been inoculated commenced to swell in from twelve to twenty-four hours, while those not inoculated remained as sound as when put in the incubator. Thus we easily proved that a vacuum is not necessary for keeping canned corn, and that air may be admitted to a sound can and spoiling will not result, provided proper precautions are
taken that the air so admitted be free from germs. This statement will undoubtedly be regarded with incredulity in some quarters, so strong is the popular belief among packers in the indispensability of a vacuum, yet a long line of experiments from the days of Tyndall to the present time prove the validity of this assertion. Moreover, there are bacteria which can develop in a vacuum, and which could find favorable conditions within cans from which the air has been expelled. Sterilization, not the driving out of air, is the important factor in keeping all kinds of canned foods; and although, as we have shown in our earlier paper, the vacuum is necessary in testing the cans, no preserving power can be ascribed to it. These experiments have been made repeatedly, and always with the result that souring takes place when living bacteria are present. The presence and activity of the bacteria in sour corn have also been shown by inoculating various kinds of culture media with material from spoiled cans. Active fermentations, of the various kinds previously mentioned, have been brought about in this way.

In order to study these fermentations more thoroughly, and to ascertain, if possible, the source of the bacteria causing them, we spent nearly the whole of the corn packing season of 1897 at an establishment in Oxford County, Maine, where every convenience for scientific study of the process was kindly put at our disposal by the proprietors. We were thus enabled to investigate thoroughly the methods of procedure, from the harvesting of the green corn to its ultimate shipment in cans.

The Process of Packing

It is very important that the utmost cleanliness and dispatch should be observed in all the operations, so that the chances of infection from bacteria may be reduced to a minimum. In this factory the strictest caution was exercised in these respects, everything being kept scrupulously clean. The corn is generally picked in the morning, and is delivered to the cannery as early as possible. One or two men make it their special duty to visit the farms once or twice a week during the season to keep informed as to the condition of the crop, and to “order in” the corn as it becomes sufficiently matured. As the ears are delivered at the factory they are arranged in low piles on the ground in an open shed to protect them from the sun. The husks and silk are taken off by hand, and the corn is then quickly carried to the cutting machines, in which, by a series of knives and scrapers, the kernels are quickly and cleanly separated from the cob. Any stray bits of cob or silk which may be mixed with the corn are now taken out as it passes through the “silker,” a machine arranged somewhat on the plan of a gravel-sifter; that is, with two cylindrical wire screens one inside the other, placed on an incline, and rotating in opposite directions. The corn drops through the meshes of the screens, while the refuse passes out at the lower (open) end.

The corn is now weighed, mixed with water in the proper proportions, and is then ready for the cooker. There are several varieties of these machines in use, all of which are alike in principle, but differ somewhat in the details of construction. Their object is to heat the corn evenly and quickly to a temperature of 82-88° C. (180-190° F.), and to deliver it automatically into the cans. A single machine fills about thirty cans a minute. The duty of the cooker is threefold: First, in the heating to which the corn is
here subjected some of the bacteria, particularly those in the vegetative state, are killed. Second, the corn being filled into the cans while hot expands the air, so that after sealing and cooling a partial vacuum is produced, which, as before stated, is essential for the detection of unsound cans. Finally, this cooking heats the corn to such a temperature that the subsequent sterilization in the retorts is brought about more quickly, and the danger of browning or scorching of the corn next to the tin is minimized.

The cans are next capped, soldered, and tested for leaks. Sterilization, the final and most important step in the whole process, now follows, and is done in retorts, by steam under pressure. The length of heating or processing, and the pressure which is given, vary somewhat in different factories. As we have shown in our previous paper, in practice, in order to insure sterilization it is necessary to obtain and maintain a temperature in excess of 100° C. (212° F.) throughout the contents of the can, and for a period of time varying with the substance to be sterilized.

**Method of Sterilization**

It is thought by some that intermittent sterilization might be employed in packing, but we consider this entirely impracticable upon a commercial scale. Intermittent sterilization consists in heating to the temperature of boiling water for a length of time varying from thirty minutes to one hour, on three or four successive days, the substance to be sterilized being cooled and kept cool between the heatings. It is supposed that in the first heating all the active bacteria, the so-called vegetative cells, are killed, while the more resistant forms, spores, retain their vitality. According to the theory, the majority of the spores germinate and become active before second heating, and in turn are killed, while by the third heating all the remaining spores will have developed into active bacteria, and will then be destroyed.

To insure success by this method of sterilization, apparatus and means must be employed which, while practicable in a small way, are in our opinion absolutely impracticable on such extensive scale as would be demanded commercially. To use this method would necessitate at least three times as much sterilizing apparatus, much more room, a greater amount of labor, and a great loss of time.

To show the resistance of bacteria to the continuous action of a boiling temperature, we have found that certain species isolated from sour corn will survive actual boiling for more than five hours, and other species of bacteria which are met with in spoiled canned goods have been boiled for eight hours without being killed. These facts serve to show conclusively the impracticability of the ordinary water bath. On the other hand, the retort with its high temperature will, if properly used, kill all forms of bacteria at a single heating, without injury to the food substance, the length of time required varying, as has already been said, with the conductivity of the medium for heat. We have found by experiment that sixty minutes at 121° C. (250° F.), as indicated by the thermometer on the outside of the retort, is sufficient time for sterilizing corn in two-pound cans, and it seems probable that this can be shortened somewhat, or the temperature reduced. Further experiments are in progress to decide this question.
Whiteness of Canned Corn

Through a demand that canned corn shall be very light in color, there has been, apparently, a pressure put upon the packer to shorten the time of heating or to reduce the temperature in his retorts. The large losses which have resulted in recent years from sour corn have, it is claimed, been due principally to this demand. Instances are known where the desired result has been brought about by some bleaching reagent, generally sulphite of sodium. While this may not be unwholesome, it greatly injures the flavor of the corn, as a comparison of such corn with that without bleachers will show. Although such cases sometimes occur, it cannot be said to be the fault of the packer: for if the dealers demand very white corn the packer must resort to some unusual means in order to render his product salable. In this connection a statement in a recent trade journal is noteworthy: "The volume of poor corn which has found its way to market in the last few years has had, and is still having, a considerable effect upon the consumption of that article, and there are a good many families who never buy canned corn nowadays because they have found little but disappointment in their corn purchases of the last few years."

It is much to be doubted if the consumer demands that the corn be very white in color. What he desires is a palatable article with a natural flavor. It seems evident that in the near future the dealers must regard this very white corn with disfavor, and reject any in this condition.

Maximum Temperature Within the Cans

By the use of small registering thermometers which can be sealed up within the cans, and which record the maximum temperature reached, we proved, in an extended study of the process as it is actually carried on at the factory, that corn is a very poor conductor of heat, and that the time necessary to bring all portions of the center of the can to the requisite temperature is a factor whose importance cannot be overestimated. Corn as it comes in cans from the cooker is at a temperature of 82 to 88° C. (180 to 190° F.). At the end of thirty minutes in a retort with a pressure of thirteen pounds, the corresponding temperature of which is 118.8° C. (246° F.), a thermometer in the center of a can placed in the middle of the retort, which was full of corn, registered 108.3° C. (227° F.). At the end of forty-five minutes, under the same conditions a temperature of 114° C. (237.2° F.) was reached and at the end of fifty-five minutes the retort temperature of 118.8° C. (246° F.) was registered by the thermometer in the can. From this it is evident that if a packer were giving his corn an hour in the retort at this pressure, the central portions of the can would in reality be subjected to the full effect of the heat for only five minutes. Thus it is evident that with the present methods any reduction of time of heating is attended by considerable risk. If any means could be devised by which the heat could reach more quickly the center of the cans, it might be safe to shorten the time of heating. There is a prospect that before long such modifications may be possible.

Bacteriology of Sweet Corn

The source of the bacteria producing the fermentations described was also a problem, the solution of which we sought with great care. Every

step of the process was investigated bacteriologically, and all channels of
infection, the water supply for example, were studied. The general cleani-
ness and the liberal use of water and steam throughout the factory which
we visited reduced the liability of infection from dust to a minimum. We
examined the green corn on the cob, the corn as it came from the cutting
machines, as it went to the cooker, as it came from the cooker, and as it
came from the retorts after the usual processing and after some periods
of heating given for experimental purposes. Living bacteria were found
on the raw corn, and at all stages of the process before the final steriliza-
tion. The corn as it went to the cooker was found to contain many germs,
but in the short heating to which it was subjected there, some of the organ-
isms were destroyed. Cans which had been retorted for thirty minutes or
less we found to contain living bacteria, and cans so treated spoiled and be-
came much distended within four days. No living bacteria were found in
cans which had received the full time of processing at this factory. By cul-
ture methods and by microscopical examination we have found that the
bacteria living upon the kernels of corn and those which we found in the
later stages of the process are undoubtedly of the same species. They all
correspond in all respects with species which we obtained from cans of sour
corn in the laboratory experiments carried on in the early part of our inves-
tigations.

All these organisms are characterized by great rapidity of growth when
allowed to develop at a temperature of 37° C. (98.6° F.). In evidence of
this fact we need only to state that of the large number of cans incubated
at this temperature many swelled within twenty-four hours, while in sev-
eral cases the cans exploded within that time. Agar streak-cultures of
these bacteria frequently showed well-marked growth within six hours,
and in some cases in four hours. The growth is much retarded at a tempera-
ture of 20° C. (70° F.). None of the organisms which we have obtained
correspond closely to the published descriptions of lactic or butyric acid
organisms, or that of the Bacillus maidis of Cuboni.

If sour corn is the result of bacterial action, the question naturally arises:
Why should a packer have trouble in a certain year, when he is using pre-
sumably the same methods of treatment that he has employed without loss
in former years? A number of conditions might exist that would account
for this. In the first place, it is a well-known fact that diseases which are
caused by bacteria may be much more prevalent in some years than in
others. The same is probably true in the case of the bacteria which attack
corn. The weather may be much more favorable for the growth of these
germs in certain years than in others, and there is good reason to believe
that a warm moist season is more apt to give sour corn than a cool dry one.
Is the packer entirely sure that the conditions prevailing within the factory
are always the same from year to year? Other things being equal, if exactly
the same methods are used, similar results should be obtained. But to all
outward appearances the conditions may be the same, when in reality they
are quite different. Differences in the steam gauges or thermometers, or a
little carelessness on the part of some operative, may be sufficient to turn the
scale and give rise to sour corn where before none had existed. That trouble
might be caused by such slightly changed conditions can be seen readily
when we realize that, as we have already shown, it is being processed in the
retort for an hour at a temperature of 240° F., or over, the corn at the
center of the can is in reality only receiving this intensity of heat for five minutes.

Believing that, in order to be of practical value, all laboratory experiments must be carried on under conditions as nearly as possible like those existing in the factory, we have recorded only such results as have been obtained under these conditions. There are still some facts to be determined which cannot be settled by laboratory experimentation, and which, owing to the shortness of the packing season, we were unable to push to completeness last year. We hope another year to investigate these points more fully.

We wish to express our gratitude and indebtedness to all those who have so kindly helped us, and particularly to Prof. Sedgwick, without whose co-operation this work would have been long delayed.

In conclusion we would again affirm:

1. That sour corn appears to be always the result of bacterial action, and due to imperfect sterilization.

2. That in case of insufficient processing souring does not always result unless the cans are subjected to conditions favorable to the growth of the bacteria within.

3. That the bacteria which produce sour corn are found on the kernels and beneath the husks of the corn as it comes from the field.

4. That the bacteria found on the ears of corn correspond in all respects to those originally found by us in cans of sour corn.

5. That swelling may be caused by bacteria other than those which produce sour corn, but it is always a natural consequence and a further development of this process of souring, provided the cans be subjected to a favorable temperature.

6. That so far as we have been able to discover, the organisms present in sour corn are capable of producing serious commercial damage and an unpleasant taste, but are otherwise harmless.

7. That a vacuum is not necessary for the preservation of canned foods, but is a valuable factor in the detection of unsound cans.

8. That the use of bleaches is not to be recommended, and is unnecessary if proper methods of sterilization be employed.

9. That the utmost cleanliness at every step is absolutely essential.

10. That intermittent sterilization is not practicable on a commercial scale.

11. That the open water bath is inefficient as a means of sterilization.

12. That with the present methods of retorting it takes fifty-five minutes for the temperature which is indicated on the outside thermometer to be registered at the center of a two-pound can of corn previously heated in the cooker to 82 to 88° C. (180 to 190° F.).

13. That heating for ten minutes with a temperature of 126° C. (250° F.) throughout the whole contents of such a can of sweet corn appears to be sufficient to produce perfect sterilization.

The paper was accompanied by a description of the micro-organisms and photomicrographs.
The Cause and Prevention of Sour Corn

S. C. Prescott


The question of preservation of food is at the present time one of the most interesting and important in the whole field of applied science, and we certainly regard ourselves as fortunate in being again asked to speak before an assembly of those who have so vital an interest in this subject. The events which have transpired since we had the pleasure of addressing the Buffalo Convention a year ago have only made more evident and more impressive the necessity for sure and safe processes of food preserving, and for more accurate knowledge regarding these processes.

So, in accepting your president's courteous invitation to speak on certain phases of the general subject, we feel that perhaps we can do no better service than to begin by briefly considering some of the facts that find application in all branches of the industry. All kinds of canned foods, so far as we are aware, are liable to undergo fermentative or putrefactive changes unless some means are taken to guard against such action. I would like, first, to speak of the causes which lead to these troubles. In the early days it was believed that the access of air was responsible, but as can be easily demonstrated by a simple experiment, this view was fallacious and we must seek further for the true cause of decomposition. The view at present held by intelligent and observing people is that these changes are brought about by the activity of very minute living things which we commonly and popularly speak of as germs, microbes, micro-organisms, or bacteria. All these terms are used somewhat indiscriminately, and all mean practically the same thing.

At the outset, I would like to caution you against a very widespread belief that all bacteria are disease-producing in their nature. As a matter of fact, the useful germs greatly outnumber the harmful ones, as the useful citizens of the community outnumber the criminals. Perhaps I cannot make the contrast more convincing than by stating that there are now on the market preparations of bacteria which are used in the ripening of cream, in the production of flavor in butter and for the increase of fertility in the soil. In fact, without the action of bacteria, we could not exist, so we must regard them as friends rather than foes, even though there are a few species which might do us injury. That the majority of them are harmless is evident from the fact that with every glass of water we drink we take in hundreds of them, and they are present in ordinary milk in great numbers. The upper layers of the soil abound in them. In fact it is difficult to find many places where they are not present.

From what I have said of their abundance, one may perhaps get an inkling as to their size. This may be best realized, I think, by some comparisons. A yeast cell magnified 50,000 times would be about as large as a football; a man magnified in the same proportion would be about fifty-four
miles high and his hand about three miles broad. We might regard a bacillus one twenty-thousandth of an inch in length as perhaps an average sized organism, while some of the largest ones might be one four-thousandth of an inch long.

The shape of these organisms may be classified as spherical like a ball, elongated like a lead pencil, or spiral like a corkscrew. These are the type forms and we get all gradations between them. Then, too, we find differences in the way in which they are arranged, sometimes being arranged singly, sometimes growing into long chains or threads and sometimes simply forming irregularly shaped groups or clusters.

We do not find these little plants complex in structure, made up of numerous organs, but rather they are very simple, being composed of a single cell. On account of the very small size, we are unable to state very definitely about the structure, except that they have a thin membranous covering like a sausage, but as in the case of the sausage also, we do not know what may be inside.

By proper means we can cultivate the bacteria, and observe the changes which they bring about in various media, and it is by such cultures, as they are called, that we learn of the nature of each particular kind of bacteria, and the chemical reactions which it will induce. On certain kinds of media we get the appearance of circular or branching spots known as colonies, each colony developing from a single germ. It is only when collected in such large masses, containing thousands or millions of individuals, that they become visible to the naked eye; to observe the single germs requires the high power of a microscope. Often they are seen in lively motion. When actively growing, or as we say, in a vegetative condition, the process of reproduction goes on with great rapidity, each germ dividing into two, these into four, and so on, thus in a few hours giving rise to vast numbers. Under favorable conditions this splitting of one germ into two may take place as often as once in twenty or thirty minutes, which at this rate would give rise to millions in the course of ten or twelve hours unless their own products of growth were sufficient to check the reproductive process. It is when in this vegetative state that the bacteria are most active, and bring about their decompositions with the greatest rapidity.

Perhaps of greater importance, from the point of view of the canner, are the more resistant forms known as spores, which are modifications of some of the rod shaped bacteria, enabling them to endure hard times or conditions unfavorable for development. When in this condition they can live for months apparently dead, but awaiting to develop again into actively vegetating forms as soon as the conditions become favorable. When in this condition, also, the bacteria are much more difficult to kill by the action of heat, hence they are a continual source of trouble to the packer unless he is certain that his process is sufficient to kill them. While ordinary vegetating bacteria are readily killed at the temperature of boiling water, or even by comparatively short heating at temperatures below boiling, the spores will frequently withstand several hours of boiling. It is not uncommon to find spores which can be boiled for five hours and remain uninjured. Some forms can endure much more than this, and we have found some in our work that are not killed by boiling for eight hours continuously. It is then obvious that simply boiling for a short time does not offer a very sure means of processing. If no spores are present there may
be no trouble, but owing to the abundance of the bacteria, we should always bear in mind that spores may be present and so formulate our process accordingly.

Although so impervious to the heat of boiling water, the spores are killed by increased heat, as for example, by steam under pressure; the more intense the heat the less time can the spore endure. This then is the true reason why retorts or kettles in which steam under pressure is used have largely replaced the water baths. This will be treated more fully by Mr. Underwood.

I have already mentioned the rapidity with which bacteria develop. It is, however, only when conditions are favorable that we find this action going on with such marvelous speed. We may regard as favorable conditions warmth, moisture, and a plentiful food supply. The substances which serve as food for us are excellent food for the bacteria, so that when present in canned goods they are generally in a most favorable environment. There is a wide variation as to the temperature which will allow development, but in general, low temperatures exert a restraining influence, while at blood heat the activity is much increased. Since the germs take in their food by direct absorption through a cell membrane, moisture is essential to their well-being, and the preservation of food by drying depends upon this fact, as in a dried state the germs can get no food and so are inactive. As soon as the amount of moisture becomes sufficient, however, they immediately begin to propagate.

But perhaps the most interesting facts about these germs are not regarding their size and shape, but deal rather with their abilities to act upon organic materials of manifold varieties, changing them into other substances lower in energy and sometimes of an entirely different nature from the original substances. So well defined are some of these processes that we might almost regard bacteria as chemical reagents, which when added to a fermentable or putrescible material, give rise to definite compounds of various kinds. This action which is brought about only by the vegetating germs forms a part of the functions of the organism just as much as our own processes of digestion and absorption constitute a part of the work of our own bodies. The spores themselves being inactive must go through a process of germination as we say, in some respects similar to the germination of a seed, before they can carry on these changes. In this germinating process the tough, resistant outer coating of the spore is ruptured or entirely cast off, and an active vegetative cell emerges. This process of spore germination only takes place when the conditions become favorable for the growth of the normal or vegetable cells. This may account for some cases of spoiling which appear to be belated, or which, perhaps, do not appear until springtime, or until the cans are put into a warm place. Then the chemical changes and the multiplication of the bacteria go on side by side until perhaps the substances formed are present in such an amount as to prevent further development.

All these chemical changes brought about by the activity of the bacteria and other micro-organisms like yeast and moulds may be grouped together in a class to which we apply the term fermentation. This term, although originally used to designate the change brought about by yeast in which a sugary liquid like a fruit juice is changed to an alcoholic one, is now used in a much broader sense, including the changes from cider and wine to
vinegar, the souring of sweet milk, and the transformation of sugars into various acids, and the breaking down of various complex substances into simpler ones. It therefore includes the changes which are brought about when canned goods undergo deteriorations caused by bacteria.

These fermentative changes can be prevented in two ways. First, by sterilization by heat, by which we mean that all bacteria, whether in a spore state or vegetative state, are subject to such a temperature that they are killed outright and therefore rendered inert. This is the general principle underlying all canning operations, and is the only sure and safe one to follow. Or, we may prevent these putrefactive or fermentative changes in another way, that is, by the use of antiseptics. By an antiseptic, we mean a substance which does not necessarily kill the germs, but restrains or prevents their development. Growth may again take place, however, if the restraining influence is removed. The use of antiseptics has many disadvantages, and notwithstanding the fact that opinions as to their wholesomeness vary, there seems to be no reasonable excuse for the use of an antiseptic in any food preparation. An objection which cannot be too strongly presented is that substances which are injurious to bacteria are also in general likely to be injurious to the human organism. Moreover, the presence of even small amounts of preservatives frequently gives an unpleasant and unnatural taste to canned goods.

In some states, as, for example, in Massachusetts, the laws regarding adulterations in foods and the use of antiseptics are stringent and well-enforced, as it is the desire of the Commonwealth to protect the health of citizens in so far as possible. Had there been any national law of this kind, we should probably not now be undergoing the deplorable war investigation.

In my foregoing remarks I have tried to make clear the facts that fermentation or spoiling in can goods in general is brought about by bacterial action and that the bacteria may be in a vegetative state or a more resistant spore state, but that in either case they may be destroyed by proper heating. Aside from these general considerations, it is obvious that, on account of the very numerous and widely different varieties of canned foods, the more specific rules which apply in one case may not at all fit another case, but that each product must be treated separately.

Bearing this in mind, I wish now to consider more in detail the subject of the fermentation of sour corn, or as it is better known to the packing trade, the production of sour corn. When this occurs a change is brought about by action of bacteria which were not killed in processing. These bacteria belong chiefly to the lactic acid group, that is, the general change is similar to that brought about in the souring of milk. In each case we have a sugar acted upon by the bacteria and split at once into an acid. In both cases lactic acid is the principal one formed. In addition to the lactic acid there are frequently produced in the corn small amounts of other acids, as acetic, formic and butyric and other products of fermentation. Gases, as carbon dioxide and hydrogen, may sometimes be produced in considerable amounts, particularly if the temperature be not too low, and in that case a "swell" is the result. At low temperatures gaseous products may be formed but at once dissolved in the liquid within the can, thus giving no swelling until the can is warmed so that the gas is driven out of solution. Or we have another variation of this fermentation taking place in which the
amount of gas evolved is very small, but almost the whole energy of the bacteria is used in splitting the sugar into lactic acid. This would take place when food conditions are most favorable. This would give sour corn without swelling. This, however, is not the only case of spoiling without swelling, as the same thing occurs with many other products when the processing is insufficient, notably “black lobster,” which has caused tremendous losses. These different modifications of the same fermentation are brought about by slight differences in the conditions, or perhaps by slight differences in the physiological activity of the germs. We may also note differences in a fermentation according as it proceeds with a plentiful supply of air, or without the access of free atmospheric oxygen. In the latter case, the oxygen necessary for the further multiplication and for the food of the organisms must be obtained by breaking down some of the substances in the corn, and in this process gases are generally evolved. As there is no likelihood that merely a single species of germ is present, especially when the action is in its early stages, we get a most complicated set of fermentations taking place, in all of which the chief product is an acid. Later, one species of bacteria may develop at the expense of the others, and the acidity produced will probably increase as the temperature is increased.

The sugar most rapidly split up by the bacteria is glucose, and undoubtedly the sweetness of young corn is due for the most part to this compound. In older corn, it is changed to starches and a little cane sugar, but in the heat under pressure to which the corn is subjected, these starches and sugars are doubtless hydrolysed, that is, they unite with water and form glucoses again. This process is not necessary, however, as the bacteria themselves can frequently bring about this change. Aside from the carbohydrate food there is no reason why fermentation should not take place if the germs are present as the water and nitrogenous substances necessary for the bacteria are present in abundance.

In addition to the recognition of this acid by taste or smell, it can be very easily demonstrated by chemical means, in fact, it might even be detected when in such small quantities that there is practically no sour taste.

The possible sources from which the bacteria might get into the cans of corn may perhaps be briefly discussed. There are five principal sources from which infection might occur.

1. From the corn itself.
2. From handling, and utensils in use.
3. From the air.
4. From the water supply.
5. From the syrup or brine.

Regarding the first three of these sources I shall say nothing, as they will be mentioned in the second part of our paper. The question of water supply, while it should not be neglected, does not have as great significance here as in some other manufacturing processes. It is, of course, desirable to have a good water supply. The number of bacteria in water varies according as a well or surface supply is used and according to the amount of organic matter present. The bacteria present in normal water are generally very readily destroyed at a boiling temperature, and many of them are killed at lower temperatures. Any spore forming bacteria would be killed in the final process as very resistant water forms are rare. Therefore, we may dismiss the question of water supply as relatively unimpor-
APPERTIZING

tant in general, although it should be borne in mind that a water supply might become so infected as to be a menace to the packer.

As it has been suggested that the syrup or brine used in the corn might perhaps be a source of infection, we have made some very careful experiments, using the components in the same proportions as would be used in actual canning operations on a large scale. We first took up the case of cane sugar. I went to a sugar refinery and obtained samples of various raw sugars and refined products. We first studied these bacteriologically, subjecting them to quantitative examination, and then making an investigation to find out if solutions of these sugars would support bacterial life. In the poorer grades of raw sugar we found bacteria to be present in considerable but not great numbers. Moulds are also quite numerous. The higher grade raw sugars, both cane and beet, contained few bacteria, and the refined product was practically free from germs.

The raw sugars when dissolved in sterilized water and allowed to stand, showed a rapid increase in the number of bacteria, demonstrating that they would support bacterial life. In the refined sugar, on the other hand, there was apparently no increase, thus showing that in the process of refining the germs are destroyed.

Pure cane sugar is not generally regarded as a good food for bacteria, yet our results showed that when nitrogenous matter is present in small amounts a five per cent solution of cane sugar will support bacterial life.

Our next experiments were made with the brine of the same composition as that used for corn. Sterilized brine was inoculated with bacteria derived from sour corn, and put into an incubating chamber at the blood heat. Development occurred, but in only limited amount, and thus far we have obtained no evidence that bacteria will develop rapidly in brine, particularly as the salt present exerts a restraining influence. The result of our work, however, showed that slight development might occur, therefore we must emphatically assert that brine should never be allowed to stand over night, and that the utensil holding the brine should be carefully washed out with boiling water each day. Unless these precautions are taken, there is the possibility that germs might develop during the night, form spores, and so infect the whole of the next day’s pack. Of course, with proper processing these spores would be killed, but if the retorts were running close to the danger line this would be less likely to happen.

The brine used in the foregoing experiments was made with sugar as the sweetening substance. As saccharin is frequently used for this purpose, we have made some investigations as to its relation to bacterial development. Saccharin is a coal tar product containing carbon, hydrogen, nitrogen, oxygen and sulphur, and in the pure state has a strong acid reaction. Probably on this account the statement is made that it is antiseptic in its action, and hence better to use than cane sugar on this account. We first studied the antiseptic power of saccharin. A strong solution was made which was neutralized by the addition of sodium bicarbonate as is directed in the rules for use. This strong solution was used as a basis, and from it more dilute solutions were prepared. The strong solution contains about three per cent saccharin by weight, and for the tests under consideration, it was used full strength and also diluted in the following proportion: 1 to 2, 1 to 4, 1 to 8, 1 to 10, 1 to 20, 1 to 50, and 1 to 100. To these solutions, in flasks, was added a small amount of nutrient substance and a cul-
ture of bacteria. The bacteria used in these tests of antiseptic value were some of the germs originally found by us in sour corn, thus making the examination of particular interest.

If saccharin was strongly antiseptic we should expect to find no growth appearing in the flasks when it was present. We found, however, that such was not the case. All the flasks showed some growth, but in those containing the strong solution there was much less than in the weaker solutions. In the latter there was practically no restraining influence at all.

These results show conclusively that the antiseptic or preserving power of saccharin has been very much overestimated. As the weakest solution used in our experiments contained about three times as much saccharin as would be in syrup or brine it is evident that it has no preserving power when used in this way. Indeed there seems to be some ground for belief that it would increase the bacterial food content of the corn. Our results would indicate that compared with cane sugar the latter has the greater preserving power as used in corn packing. Saccharin is, however, much sweeter, although to many the taste is objectionable.

It has been reported that the use of saccharin in any food product has been prohibited by law in Germany on the ground that it is injurious to health. In this country, however, it is not regarded as an adulterant, as sufficient evidence of any injurious nature is lacking, and its use in canning will doubtless remain a matter of individual taste among packers.

From what has been said regarding the effect of temperature on the development of bacteria, I think you can readily see why it is that some seasons are far worse for packers than others, and why some localities may suffer more severely than others even if they are not far distant. Thus, in a very hot summer, like last season, Maine would have a decided advantage over New York and the Central States, because of its more northern latitude, and consequently cooler climate. In a similar manner a wet or a dry season probably exerts an influence on the development of germs in nature, but as data on these points are necessarily hard to obtain we can do no more than call attention to them.

In this paper I have tried to express briefly, and I hope in a clear and straightforward way, what we regard as some of the important facts from the point of view of the canner. I hope I have shown the necessity for scrupulous care in every step of the whole canning process. In view of the many sources from which trouble may arise I believe the best results will not be obtained until some measures are taken to obtain accurate scientific information along these lines. I can see no reason why the knowledge of the fundamental principles should not be sought just as eagerly in the preservation of food as in any other branch of manufacturing. Surely none can be of greater importance to the public welfare. It is very easy to talk learnedly and at length about science in the abstract, but unless one can show just how this science has a practical bearing on the problems that are daily encountered in the industrial world, such talk is vain and may be wrongly construed.
The Cause and Prevention of Sour Corn

W. Lyman Underwood

Last year when I had the pleasure of addressing you at the Buffalo Convention I told how, in order to discover the cause of a mysterious loss which we were experiencing with one of our products, I became interested in the study of bacteriology as applied to our business—the canning of fish and meat.

This question being solved and a remedy for the deterioration having been applied with success, I naturally became interested in some of the fermentations occurring in other branches of the industry. Sour corn, being the most prominent, about two years ago, with Mr. Prescott, I began an investigation of this subject and we have been working on it ever since.

As there are many packers present who were not at Buffalo last year, we have thought it best to make our papers somewhat in the nature of a review, although there are many new facts which are brought to your attention. At the conclusion of our article, which was presented to you at that time, we summed up our work as follows:

1. That sour corn appears to be always the result of bacterial action and due to imperfect sterilization.

2. That in case of insufficient processing souring does not always result unless the cans are subjected to conditions favorable to the growth of the bacteria within.

3. That some of the bacteria which produce sour corn are found on the kernels and beneath the husks of the corn as it comes from the field.

4. That these bacteria found on the ears of corn correspond in all respects to those originally found by us in cans of sour corn.

5. That swelling may be caused by bacteria other than those which produce sour corn, but it is also a natural consequence and a further development of this process of souring, provided the cans be subjected to a favorable temperature.

6. That so far as we have been able to discover, the organisms present in sour corn are capable of producing serious commercial damage and an unpleasant taste but are otherwise harmless.

7. That a vacuum is not necessary for the preservation of canned food, but is a valuable factor in the detection of unsound cans.

8. That the use of bleaches or any antiseptic material is not to be recommended and is unnecessary if proper methods of sterilization be employed.

9. That the utmost cleanliness at every step is absolutely essential.

10. That intermittent sterilization is not practical on a commercial scale.

11. That the open water bath is insufficient as a means of sterilization.

12. That, with the present methods of retorting, it takes at least fifty-five minutes for the temperature which is indicated on the outside thermometer (say 250°) to be registered at the center of a two pound can of corn previously heated in a cooker to 189 to 190° F.

13. That heating for ten minutes with a temperature of 250° F. through the whole contents of such a can of sweet corn appears to be sufficient to produce perfect sterilization.
Another year's experience has more than convinced us of the correctness of these assertions.

In treating this subject we assume that the corn is in a perfectly sweet condition when it goes into the retorts in the can, and in our experience at many factories, we have always found this to be the case. Two facts prove the correctness of our assumption. First, we have found living bacteria present in cans of sour corn, thus proving that the sterilization was insufficient. They have been found repeatedly and with corn derived from many factories in widely separated localities. Second, in a large number of cases, especially in its first stages, souring may be found only at the center of the can. When sampling a pack of corn where trouble is suspected, this fact is often noticed. The corn may be sweet at the top of the can, but on taking a sample from the center, souring will be found. Should these cans stand at a favorable temperature for some time the infection will become general throughout the whole contents. This proves that the heat sufficient for complete sterilization has not penetrated to the central portion on account of the low conducting power of green corn. It is, of course, possible that corn may become sour before going into the cans or before it reaches the retort, but it would be only under conditions of gross carelessness that it could occur in practice. If the corn had been sour before it was processed, this condition would not have been at first confined to the center of the cans, but would have been equally distributed in all parts, and no amount of sterilization or processing could sweeten it again.

As has already been stated warmth is particularly favorable for the growth of bacteria. The organisms which infest sour corn develop most rapidly in a temperature at or about blood heat. Upon this property of the bacteria depends the great and elaborate system of cold storage. A low temperature is not necessarily fatal to bacteria, but it prevents their growth and so arrests fermentations brought about by them.

As a striking illustration of this principle we may cite the following facts: A Maine packer made two shipments of corn from the same day's packing, one to Bangor, Maine, and one to St. Louis, Mo., while a third portion of the same lot remained in his storehouse. In the following summer he received notice that the corn which had been sent to St. Louis had turned sour, while no complaint was received from Bangor. On examining the lot remaining in the storehouse no trace of sour corn could be discovered. These results are absolutely to be relied upon as this particular day's pack was under suspicion and had been set aside and all shipments from it carefully recorded.

In seeking the sources from which the bacteria causing this trouble might have come we examined ears of fresh green corn and upon the kernels and beneath the husks we have found bacteria which correspond in all respects to those previously obtained from cans of sour corn.

There are many bacteria which can produce sour corn but we regard these as the particular ones most likely to give rise to the trouble.

After the Buffalo Convention last year the statement was made that it would not be possible to isolate bacteria from cans of corn on account of the many thousand germs which were floating about in the air, since these germs were bound to get upon anything taken from the cans. This being the case it was said we would not be sure that any bacteria had come from the
corn. In fact, the germs which were found must have come from the air and not out of the cans at all.

We will tell you how we obtained these germs and you may use your own judgment as to whether or not we are right in our conclusions. Imagine a glass case some two and a half feet square with a door on one side which opens by sliding upwards. First the dust was entirely removed from the inside by washing with a cloth wet with a strong solution of corrosive sublimate. The cans to be tested were washed with the same solution, then placed inside the case, together with a Bunsen burner and an awl which were also sterilized. Now, washing the hands with corrosive sublimate and lighting the Bunsen burner, we are ready to begin. The door of the case is raised sufficiently to allow the admission of our hands. The awl is heated red hot and the can to be punctured is held over the flame and the hot awl is pushed through the tin. Should there be any vacuum in the can the flame, which must be germ free, will be drawn in, but no living germs can go with it, even if there should be any inside the case. Now with the platinum needle brought through this small hole and placed in the tubes of sterile culture media. If the can contained bacteria some of them would probably be taken out with the material on the needle and they would then continue to grow in the culture tubes, from which, by the usual methods, pure cultures could be obtained. No bacteria were found in sound or good cans of corn when treated in this same way.

There may be two varieties of sour corn distinguished as “flat sours” and those which show springy ends or “swells.” We regard the latter as a further development of the former, which has been brought about by favorable conditions of temperature. However, we do not wish to give the impression that sour corn will always swell. As has already been said by Mr. Prescott, there may be a fermentation in which only acid and almost no gas is produced. If, however, the temperature be high enough there is generally a smaller or larger amount of gas evolved. This fact is made use of in the tests for sour corn which we gave you in our paper last year.

The fermentations arising in sour corn are similar in their cause and results to those occurring when milk sours. In each case we have an undesirable product, yet we cannot regard it as essentially dangerous to health. Many people even like sour milk as buttermilk, and in some countries it is used as a part of the daily diet. So far as we have been able to ascertain none of the germs which we have found are disease-producing.

As we told you in our paper last year the vacuum is not essential for the preservation of canned goods, but is necessary in a way as an aid in inspection for the detection of unsound cans. It may seem needless to dwell upon this statement, yet so firmly has this mistaken notion that a vacuum is necessary become rooted in the public mind that even at the present time many people regard it as truth. It is well known to bacteriologists that many germs can live and develop in a vacuum, the presence of air actually preventing their growth. We can readily show by experiment that a vacuum is not essential for the preservation of corn and other canned foods. It is not the air which is harmful but the germs which may be contained in it, as we can easily prove by sealing a package with some substance, which, while freely admitting air, acts as a filter, thereby preventing the entrance of bacteria.
(Mr. Underwood here showed flasks the openings of which were sealed with plugs of cotton. In them were shell fish, which though they had been processed over two years, were in an excellent state of preservation.)

During the past two years the demand for very white corn has decreased somewhat, for many dealers are already looking with suspicion upon it. The following incident will serve as a practical illustration of this statement: While in one of our large wholesale grocery houses quite recently, my attention was called to some corn which I knew had been processed according to our suggestions. I asked how this brand was selling and was told that it had the best sale of any line of canned goods in that house. They had heard nothing but praise of it though it was considerably darker in color than the corn which had been put out by the same packer three years ago.

Here was an article containing no bleacher and thoroughly processed, thus insured against souring, which had an excellent sale at a high price, giving satisfaction to packer, dealer and consumer, because of its superior natural flavor.

Our attention has been called to a circular issued by a well known canned goods manufacturer which also has a bearing on this subject. We quote an extract from it:

“Our corn contains the natural cooked color and flavor due to complete sterilization and absolutely healthful ingredients, and we hope our patrons and consumers will aid us in destroying the market for white bleached or underdone canned corn; that all suspicion of a deleterious foreign substance may be removed.”

We have here two views of this subject, that of the producer and that of the consumer, both in close accord, and were they accepted by all it is our opinion that sour corn would soon be a thing of the past. It is the fear that his product will be made unsalable that deters the packer from processing his corn to the extent required for complete sterilization. Heat and heat alone should be the agency employed as a preservative for all canned food and the use of antiseptics, whether for bleaching or for any other purpose, should be condemned.

Too much attention cannot be paid to the question of cleanliness since it reduces the danger of infection. Dust and dirt are the vehicles by which bacteria are often carried, and it is essential that such conditions should not exist. The liberal use of water and steam will do much to remove the chances of trouble from these causes. A frequent source of infection and danger is found in the piles of corn-cobs which are sometimes allowed to accumulate near the factory. Here fermentation sets in and in a short time multitudes of bacteria may be produced, which, upon drying, are easily carried by currents of air into the buildings. It is also important that the utmost despatch be exercised in handling the corn before it reaches the process room, that the liability of infection may be reduced to a minimum.

There are three methods of sterilization by heat which may be applied:
1. By steam under pressure in retorts.
2. By continuous boiling as in an open water bath.
3. By intermittent or discontinuous boiling.

As the last method is much in use in laboratories for sterilization of small amounts of materials, and is sometimes suggested as being practical on a
larger scale, we wish to outline the principle and the process involved. Mr. Prescott has already told you that bacteria, when in the spore state, are very resistant to heat and that they do not always remain in this state of development. This fact is taken advantage of in the process of intermittent sterilization. Assume that a substance to be processed contains numerous bacteria, both in the spore state and in the vegetating condition. The substance is heated for a short time, perhaps thirty to sixty minutes, at a boiling temperature, 212° F. In the first cooking all vegetative organisms are killed, while the spores remain unharmed. The goods are now set away until the next day when the process is repeated. In the meantime some of the spores will have developed into vegetative forms, owing to the favorable food conditions. These are destroyed by the second heating. After the second heating the substance is again set aside for another day to allow the development of the remaining spores, and is then given a third and final heating, which, according to the old ideas, should produce complete sterilization. It will readily be seen that the use of this method involves the handling of goods a number of times, and moreover, requires a much greater outlay in plant and labor. Aside from the impracticability of adopting this method on a large scale, there are a number of other serious objections to its use, particularly with a substance like corn, which, as we shall presently show, is a poor conductor of heat. It may be sufficient to say at this time that in order to make the process at all efficient each heating would necessitate more than an hour's time. We have proved that it takes an hour and forty-five minutes for a temperature of 212° F. to reach the center of a can of corn. Moreover, there can be no absolute certainty that all spores of bacteria would develop into vegetative forms by the time of the third heating, and unless this were so the whole process would fail of its end.

In preserving nearly all the more putrescible foods, the open water bath has been almost entirely given up as an agency of sterilization. Practical experience has demonstrated that it is unreliable. Within the past year we have been in communication with a packer who had up to 1898 always processed his corn at boiling temperature. He frankly told us that they had had more or less sour corn each year and were very much puzzled by it. When one bears in mind that the spores of bacteria will often withstand eight to ten hours of boiling, the reason for this loss is not difficult to see; and it also offers a striking example of the insufficiency of this method. On the other hand, the use of steam under pressure, by which temperatures high above the boiling point of water may be reached, undoubtedly offers the best means of processing corn. So far as we can ascertain this is a safe and sure method if properly controlled. To obtain satisfactory results, however, it is necessary to know definitely the time which is required for the heat to penetrate to all parts of the can at whatever temperature it is the custom of the packer to give.

In order to determine more thoroughly the relations of time and temperature which should govern the sterilization or processing of corn, we have carried on during the past season a prolonged investigation of this subject involving over 400 tests, made both in wet and dry retorts, and in a number of different localities. The corn which was used in these experiments was of a consistency of the standard New York quality which had been run through the cooker at about 185° F. This corn was processed
at the following temperature: 235, 240, 245 and 250° F. and at each of
these temperatures different periods of 40, 45, 50, 55, 60, 65, 70 and 75
minutes were given. The method of procedure was as follows: In the
center of each can was placed a thermometer which registered maximum
temperature reached. The cans were distributed in different portions of the
retort and each test was repeated several times in order to get a larger
number of heatings from which to obtain our average results and to dimin¬
ish any liability of error. The time was first taken when the outside ther¬
mometer showed the temperature at which the run was to be made, and at
the end of the period of heating the cans were immediately cooled in cold
water. The thermometer readings were then taken and the averages ascer¬
tained. As these may be of interest to you, we will give them in detail:

<table>
<thead>
<tr>
<th>Minutes</th>
<th>235°</th>
<th>240°</th>
<th>245°</th>
<th>250°</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>226</td>
<td>233</td>
<td>234</td>
<td>237</td>
</tr>
<tr>
<td>45</td>
<td>227.5</td>
<td>234.5</td>
<td>236.5</td>
<td>240.5</td>
</tr>
<tr>
<td>50</td>
<td>229</td>
<td>236</td>
<td>239</td>
<td>244</td>
</tr>
<tr>
<td>55</td>
<td>231</td>
<td>237.4</td>
<td>241</td>
<td>247.5</td>
</tr>
<tr>
<td>60</td>
<td>233</td>
<td>239</td>
<td>243</td>
<td>250</td>
</tr>
<tr>
<td>65</td>
<td>235</td>
<td>240</td>
<td>245</td>
<td>250</td>
</tr>
<tr>
<td>70</td>
<td>235</td>
<td>240</td>
<td>245</td>
<td>250</td>
</tr>
<tr>
<td>75</td>
<td>235</td>
<td>240</td>
<td>245</td>
<td>250</td>
</tr>
</tbody>
</table>

For comparison we have tabulated these results in the manner shown
above. The figures in the first column indicate the duration of heating in
minutes. At the head of the other columns are given the temperatures at
which the tests were made while the figures below give the temperatures
obtained for the different periods of time. In this way we can easily show
the length of time required for heat to penetrate to the center of the cans
at any given temperature. It will also be noticed that the higher the temper¬
ature of the run the more quickly the heat reaches the center of the can.

The results of these tests should not be applied universally, as the con¬
ditions may vary somewhat between individual packers or different locali¬
ties. The conditions here referred to apply particularly to the consistency
of the contents of the can, whether it be a very moist or a very dry pack.
The amount of starch in the corn would influence the temperature some¬
what; that which contained the more starch would take the longer to heat
as would also be the case with corn which had but little moisture added as
brine or syrup.

Our opinion has often been asked as to the advantages of the wet over
the dry retort or vice versa, and we will give the facts as far as we have
been able to obtain them from this line of investigation.

We in New England hardly know what a wet retort is and I myself have
never seen one in use there, about all the processing being done with dry
steam. It is a common thing to hear a packer say, “If water should stand
in our retort it would spoil the cook and the goods would not keep.” In a
way he may be right, though the trouble would not be due directly to the
presence of water. In running a dry retort it is very important to have a
free exhaust to insure perfect circulation of steam and an even heat. With¬
out it the circulation would be very imperfect and the temperature in some
parts of the kettles might be lower than that indicated by the outside ther¬
mometer. With such conditions we shall find water in the retorts which has
condensed from the steam and its presence is a direct indication that the
heat might not have been equal in all parts of the retort. It is also important that a good exhaust be given in running a water retort as the rules of circulation and distribution of heat are similar in both cases. Our experiments with both methods have been made with retorts which were run correctly but in the usual way. Under these conditions we have found no advantage to be gained by the use of one kind rather than the other, unless it be a question of convenience, or work in handling. In both cases an equal time is required for a given temperature to be registered in all portions of the retort, and no preference can be shown. The figures which we have given relating to heat and time were derived from both methods and can be applied to one or the other.

As before stated, these tests cover all portions of the retort and from them we gain some knowledge of what has been considered rather a perplexing question, namely: Does it take longer for a given temperature to reach the central cans in a full retort than it does those at the top, bottom or sides, and is the heat at all times equally distributed? Our tests have shown that at periods between 30 and 60 minutes at temperatures from 235 to 250° F., the central cans are heated as quickly as any other, and the heat is evenly distributed throughout the retort. A very slight difference was noticed in short runs between the central and outside cans, but it was so small as to be of no practical disadvantage.

We have often heard it stated that the wet retort gives a better quality of “cook” than does the other method. It is claimed by many that the dry retort has a tendency to over-cook. This certainly has never been proved to our satisfaction, and we think a little deliberation on the subject will show that it is not a fact. Two kettles of corn were processed for 65 minutes at 250° F., one was filled with water and the other was run with dry steam. They were so timed that the cans from each were withdrawn and cooled together. After cooling, six cans were opened from each lot and no difference could be noticed in texture or in color. We have made similar tests with other goods besides corn, and with the corresponding results. At first thought it would seem that the water retort must give a different quality of cooking, but it must be remembered that in each case the temperature was exactly the same and the cans being hermetically sealed the contents could not be affected by the water. The difference between processing with dry and wet retorts should not be confounded with ordinary roasting and boiling.

We may roast a piece of beef or we may boil it. Here there is a vast difference in the condition or texture of the meat so treated. But there is also a great difference between the methods of cooking. One is a very dry heat at a very high temperature; the other a moist heat at a comparatively low temperature. In both cases this heat comes in direct contact with the food, in the first instance driving the moisture from, and in the second adding moisture to the meat; while in the retorting of canned food, moisture can be neither taken from nor added to the substance in the cans.

Every packer should know to his own satisfaction just how long it takes the temperature at which he is processing to reach the center of the cans of corn which he himself is packing. Never mind what your neighbor is doing. He may be packing corn that never sours and is giving it but 55 minutes at a temperature of 245° F. while your corn is sour which was given 65 minutes, 10 minutes more than he gave, at the same or perhaps even a
higher temperature. But he forgot to tell you, or perhaps he did not know, that he was adding a much larger quantity of water than you were. To show what an important factor the amount of water is, I may state that a registering thermometer, placed in a can of cold water, will show the same degree of heat that is indicated on the outside retort thermometer, say 240° F., in six minutes, while it takes about 65 minutes for a registering thermometer in a can of hot corn of standard quality to show the same temperature.

Some packer may tell you that the limit of heat is reached in his pack of corn in 30 minutes. He knows this is a fact because he has used registering thermometers, but should you investigate his methods, you would likely find that his thermometers were not placed in the center of the cans. They may have been placed in the center of the cans, but no precautions taken to keep them there, so that the heat recorded was from the side of the can, not from the most important point, the center.

Experiments are of little use and may be often misleading unless they are carried out with a thorough knowledge of the principles involved. Sooner or later the rule of thumb methods must give way to the application of scientific laws, and there is no industry in which their application has larger scope than in that in which we are all engaged, the preservation or canning of food.

WILLIAM UNDERWOOD, PIONEER AMERICAN CANNER
Discoloration in Canned Lobsters

REPORT OF AN INQUIRY INTO THE CAUSES LEADING TO A DETERIORATION IN THE QUALITY OF CANNED LOBSTERS

By Andrew Macphail, B.A., M.D.

INTRODUCTION

Before undertaking this inquiry, it was necessary to measure the importance of the work in hand, to ascertain the amount of labour it would be thought advisable to bestow upon it. This problem was approached from various sides.

1st—The value of the industry.
2nd—The extent of the deterioration.
3rd—The loss entailed thereby.
4th—The distribution of the loss.

The following facts are therefore submitted, because it was the consideration of them which pointed to the necessity of an extensive and elaborate research. If any results were to be obtained, it was only by proceeding in an orderly manner and to great lengths, if necessary. Even if no results were to be arrived at the preliminary work would have been done for some more fortunate observers. Therefore, the inquiry was projected upon a wide and sound basis, and the various operations are set forth along with the conclusions to which they led.

1. VALUE OF THE INDUSTRY

Statistics are available in a supplement to the twenty-fifth annual report of the Department of Marine and Fisheries. In it the Deputy Minister states that the number of cans packed in Canada that year was...
14,285,157, or nearly 300,000 cases, which at the nominal price of $8 a case amounted to $2,400,000.

The value of the export of lobsters in 1891 was—$1,930,175
The value of the export of lobsters in 1892 was—1,909,756
The value of the export of lobsters in 1893 was—2,071,225
The value of the export of lobsters in 1894 was—2,331,660
The value of the export of lobsters in 1895 was—2,135,756
While last year the value amounted to…………………………2,489,995

The average price per pound in 1883 was 9.12 cents; in 1893 it had risen to 14.10 cents; at present it is 18.72 cents.

2. The Extent of the Deterioration
3. The Loss Entailed Thereby
4. The Distribution of the Loss

These three factors will be considered together.

It is a matter of exceeding difficulty to estimate accurately the annual loss sustained by the industry through deterioration in the quality of the goods, by blackening and other causes, because the loss falls in so many quarters.

First, there is the loss to the individual packer; then to the buyer, the wholesale merchant, to whom the goods are sent, to the retail dealer, and finally to the consumer, who probably bears the bulk of it, and whose loss can never be ascertained.

To obtain some expression of opinion, a communication was addressed to packers, buyers and dealers in the Maritime Provinces of Canada, the United States, and Great Britain.

It contained two questions:
1st. What do you consider to be the causes of the depreciation in the quality of canned lobsters?
2nd. What, in your opinion, is the annual loss to the lobster packing industry through this deterioration?

From some of the factories came replies that they sustained no loss whatever. This fortunate condition is explained by the fact that these packers market their goods twice a week before any considerable change is manifest, receive their money, and the transaction so far as they are concerned, is finished. The first buyers ship the goods on commission and receive what the consignee can afford to send. This then is a source of information. In this connection, the following extracts selected from many letters are of value as showing the feeling of the trade in England:

From W. & D. Harvest, Dowgate Dock, Upper Thames St., London, E. C.:
"We trust the experiments you allude to may produce satisfactory results. Certainly, the present canned lobsters form so capriciously perishable a stock that the trade is avoided as much as possible by importers, dealers and retailers."

From Messrs. Crosse & Blackwell, Soho Square, London:
"There is a great need of improvement in the preservation of lobsters, as there have been special difficulties in the past few years."

From Petty, Wood & Co., Nos. 41-57 Southwark Bridge, London, S. E.:
“We think it is quite time some steps should be taken by the Canadian Government to regulate and try to secure the packing of fish which are sound and fit for the food of man and also to stop the shipment of rubbish and unsound food.”

From Powell Bros. & Company, No. 27 Mincing Lane, London, England:
“The whole industry for years past has been going from bad to worse owing to the unsatisfactory out-turn of the major portion packed: in fact, to such a pass has it come that many firms have repeatedly expressed to us that they will need to seriously consider abandoning the sale of canned lobsters, owing to the unpleasantness and difficulties in which they are so constantly involved.”

From the Cunningham & DeFourier Company, Limited, Great Alie St., London, England:
“It is our opinion that unless some prompt action be taken, the trade in these goods will practically cease as regards Great Britain.
“For our part, we have made up our minds to discontinue offering lobster next season unless we can see an improvement in the pack, as the complaints which come to hand and which we have to satisfy by allowances, make the business very troublesome, and it is doubtful taking all things into consideration, if we make any profit by handling these goods.”

From Samuel Hanson, Son & Barter, No. 47 Botolph Lane, London, England:
“There is no doubt whatever that unless something is done to improve the packing, the trade in canned lobsters, which has already seriously declined, must go from bad to worse, to the injury of all concerned.”

From A. W. Latham & Co., No. 17 Philpot Lane, London, England:
“If this blackening can be removed, it would be an enormous value to this industry for at present the marvelous uncertainty as to whether lobsters, from wherever they may come will show smut or turn black sooner or later, is one of the curses of this trade leading to endless difficulties and creating all sorts of dissatisfaction: in fact, if we were not obliged to handle lobsters, we should strike them off our list and thereby save ourselves much worry and loss.”

The replies received from Mr. J. E. Grant and from Mr. W. F. Tidmarsh of the Portland Packing Company are to the point. In his reply Mr. Tidmarsh says: “I think I would be quite safe in saying that if the ‘blackening’ so called, could be prevented, and the lobster preserved so as to retain its flavour and texture, when the confidence of the trade became established, the value would be increased by at least three dollars a case, representing a total in money value to the industry in Canada of about $900,000 per annum.”

Messrs. Macdonald & Bros. estimate the loss at two dollars a case, which according to the annual output is equal to $600,000 a year.

Mr. Grant in his reply says:
“It is very difficult to answer your inquiry fully, as the loss does not frequently fall upon the packer, he realizing on them through the dealer, who ships them to the different markets of the world, and who in reality meets with the first loss and ultimately the jobbers who buy them at a price and keep them in stock awaiting the demands of the trade. Some seasons I know the jobbers lose all their goods. As a dealer I can speak
very feelingly and can say that I have lost thousands of dollars by shipping lobsters on consignment. The only certain method in handling lobsters is to get rid of them as quickly as possible. It might be interesting to you to know the actual commercial value of a choice can of bright lobsters. Few realize the fact that the choice parts of eight lobsters go to fill a one pound can.

“The consumer thinks nothing of paying 12½ cents for a fresh lobster. Multiply by eight and the can of lobsters show a value of one dollar. Now, if the canning of lobsters could be brought down to an exact scientific process and the consumer could be guaranteed that the goods were as good as when fresh, the question will answer itself.”

As long ago as 1887, Inspector Duvar wrote:

“Owing to the inferior grade of goods prepared by some packers, the lobster business is in great danger of being seriously imperilled. Canadian packed lobster is at a very low ebb in English markets, so much so that London green-grocers will have nothing to do with Prince Edward Island lobsters on account of their inferior quality.

“From this it is clear that the loss is a very material one, not only in the deterioration of the present product, but from the fact that the best quality now produced is inferior to that which should be obtained and can be obtained by the adoption of scientific methods.”

Description of Damaged Cans

This deterioration in the quality of the contents of cans is variously referred to as “blackening” or “smut,” and other cans are known as being “sour,” “acid,” “fermented” and “blown.” This points to the fact that the deterioration manifests itself in various forms and is due to widely different causes.

It will first be necessary to describe the appearances presented by a series of damaged cans. Upon opening a large number it was at once seen that there was the largest possible variety of condition. Indeed the discoloration was absent in many cases and the degree to which it had proceeded was different in all. In some the contents were uniformly dark, the colouring matter penetrating the whole tissue. In others it was confined to that portion which was in contact with the seam of the can, and at the junction of the cover and bottom with the two ends of the cylinder. Again it occurred in spots corresponding with the puncture made in the cover to allow the air to escape or to assist in the process of sealing. In these places the continuity of the tin coating was broken, allowing the middle plate of iron to come in contact with the contents. Again, the discoloration commenced over small areas where the tin was eroded, but whether this erosion was due to a primary defect in the material or whether it was due to some solvent action of the contents had to be reserved for further examination and will be referred to later. In some cases the paper lining was alone discoloured and in others a space along the seam of the can.

In most instances the contents remained solid though discoloured. Some were liquid and uniformly black and others liquid but of a normal colour. Many cans were bulging almost to the point of bursting with gas, and when punctured the gas escaped with a rush and foul odour while in others the amount of gas was imperceptible.
METHOD OF INQUIRY

We are now able to define the scope of the inquiry as follows:

1. To classify and describe the different forms of deterioration.
2. To ascertain their causes and consider the various theories in vogue respecting them.
3. To determine whether they began to operate before or after the process of canning commences.
4. To consider the present methods.
5. To provide a remedy and prepare a scheme for the profitable preservation of lobsters.

DISCOLORATION AND ITS CAUSES

First of "blackening." This should be described as "discoloration," for the colour varies from a faint brown, a brilliant purple, a luminous yellow to a condition of inky blackness.

Of this discoloration we have separated seven different kinds all due to different causes which are here described in detail.

1. Brownish discoloration of the paper alone.
   This form was found to be due merely to scorching with an over-heated copper too long applied. To determine this a can empty except for the lining, was sealed with a very hot copper; on opening, the paper was found scorched as described. Again a similar discoloured area was removed from the lining of a can and treated with hydrochloric acid. The colour was not removed, proving it was due to organic destruction of the paper by heat, and of no serious moment excepting in respect of appearance.

2. A yellowish discoloration of metallic lustre along the seam of the can.
   This is observed in many cans newly made and before the lobster is introduced and is due to excessive heat in the soldering of the can itself, as can be shown by applying an overheated copper for an unusually long time to a piece of tin plate when a similar result is produced.

3. A purplish discoloration observable immediately after the cans are removed from the second bath, which will be dealt with in considering the "Remedy."

4. Sulphide of Iron

In another series a blackness as intense as that of ink was observed commencing where the raw edge of iron was exposed along the seam, around the covers and at the probe holes. This gradually extends to the contents of the can. This substance is soluble in hydrochloric acid and yields a precipitate of sulphur. When filtered and diluted with distilled water and a stream of sulphuretted hydrogen passed through, no precipitate is obtained, indicating that no lead or tin is present. If tin were present we would have a brown precipitate and black in the case of lead. If, now, ammonium sulphide be added, a black precipitate is brought down which is soluble in hydrochloric acid, and with potassium ferrocyanide yields the reaction of a ferrous salt. This discoloration then is due to sulphide of iron, and is caused by the sulphuretted hydrogen acting upon the iron. The sulphuretted hydrogen arises from the putrefactive fermentation of proteid matter, under the influence of micro-organisms, as will afterwards appear.
5. Sulphide of Tin

This produces a uniform brown tinge upon the paper. This material when treated with hydrochloric acid and sulphuretted hydrogen, produced a brown precipitate of proto-sulphide of tin, which dissolved in sulphide of ammonium, giving sulphide of tin; when acid was added a yellow instead of a brown precipitate was separated. This is the reaction of a stannous salt, the sulphide of tin being formed in the same manner as the sulphide of iron.

6. Oxide of Iron

A yellowish brown rust upon the raw edges of iron due to common oxide of iron. A can was filled with a solution of salt and water and boiled for three hours, when a similar condition was produced. The material from the can answered all the tests for oxide of iron, that is to say, caustic alkalis gave a brick red precipitate of ferric hydrate insoluble in hydrate of potassium; ferrocyanide of potash gave a blue precipitate, and sulphocyanate of potash gave a deep red colour.

7. Bacterial Action

Discoloration due to bacteria. In many cans which are in the early stage of putrefaction one observes colonies of bacteria upon the surface of the contents giving a uniform brownish tinge. This may be scraped off, leaving the tissue beneath of normal colour.

From the foregoing it will appear that the ultimate source of a large series of discolorations is the presence and operation of bacteria.

It was therefore clear that an exhaustive bacteriologic study would have to be undertaken. To this end, it was necessary to establish a laboratory where abundant material was accessible. Accordingly in May, 1896, this was done in Charlottetown, Prince Edward Island, with all the necessary appliances. The work was continued there till the latter part of June and recommenced early in July to investigate some matters which were overlooked during the first visit.

Gases

The sign of deterioration most eagerly sought for is a bulging of the ends of the cans due to an accumulation of gas within. These gases are a product of bacterial activity, and upon analysis were found to be composed chiefly of:

Sulphuretted hydrogen. Carbon dioxide.

The material from which sulphuretted hydrogen may be readily formed, is often introduced into the can by the non-removal of the gut and its contents. The stomach and gut of a living lobster were placed in a test tube with acetate of lead paper, within six hours sulphuretted hydrogen was developed in appreciable quantity and rapidly discoloured the edges of the plate placed in contact with it.

Theories in Vogue

Among the numberless theories as to the cause of "blackening" of lobsters the use of acid easily holds the first place. Now, as a matter of fact, if a portion of lobster tissue be immersed in pure hydrochloric acid for a few days it becomes beautifully white. Therefore, the use of acid in the
manufacture of cans has been almost abandoned, and much ingenuity has been displayed to procure a suitable substitute. The general consent is in favour of employing a mixture of rosin and linseed oil. Another preparation is made as follows: "add one pound melted rosin to a gallon of lard oil, and stir to the consistency of cream." The effect of strong acid upon the tin is of course to dissolve it, but when tin is etched by a dilute acid the effect is to dissolve the minute crystals more quickly than the larger ones, giving to the surface a frosted appearance (moiree metallique).

Seasonal Influence

To determine what influence, if any, the time of year in packing exercises, small packs were made in the following months, May, June, July, August, October and December. Upon examination of cans packed at these various periods it was not possible to observe any difference in quality in respect of colour.

The Question of Molting

It is worth inquiry if there be any connection between the deterioration and the molting of the lobster, but before doing so, it will be necessary to discuss the details of the process by which the shell is cast.

All shell-fish grow in stages. They are surrounded by a hard inelastic covering, and when in the process of growth this covering becomes too small, it is cast off. This is known as molting. The process was well studied by Vitzow in the marine laboratory of Roscoff, and by Francis Hobart Herrick in the laboratory of the United States Fishery Commission, at Wood's Hole, Massachusetts, from whose excellent report many of these physiologic statements are taken. The shell of a lobster varies in hardness and colour, depending upon the period since the last molt. An animal which has recently cast its shell is known to fishermen as a "soft shell," "new shell," "paper shell," or "buckle shell" lobster, and just previously to molting as an "old shell," or "black shell."

In Prince Edward Island it is unusual to obtain soft shell lobsters before the middle of July, at which time a few may be found in the traps with the cast off shell by their side, or the shell alone may be found, the animal having escaped by reason of its smaller size. The newly molted lobster lies limp and helpless, but is covered by a limiting membrane resembling, in shape at least, in every respect the shell itself. Not only is the shell cast off but the lining of the stomach, oesophagus and intestine is exfoliated as well, these structures being derived from infoldings of the skin. Water is now quickly absorbed and the flesh converted into a pulpy mass. There is now a marked increase in size and a rapid hardening of the new shell.

Many factors go to account for this rapid growth of the shell. On each side of the stomach of a molting lobster are found two bodies an inch long and half an inch thick composed of calcareous matter and known as gastroliths. These bodies may be, as Vitzow suggests, "dissolved in the acids of the stomach and entering the lymph form an inorganic reserve comparable to phosphatic plaques found in the membranes of the foetus in ruminants." On the other hand, Herrick may be right in holding that these gastroliths "represent the lime which has been removed by absorption from the old shell preparatory to the molt." But there is a more obvious source of supply of the calcareous matter necessary for the formation of the new
shell. After molting the lobster is in the habit of swallowing fragments of shell, which are changed in the stomach to acid phosphates and thence carried by the blood to the locality where they are needed. It is difficult to say what period must elapse before the shell acquires any considerable degree of hardness. Reaumur, speaking of the crayfish, says that he has seen the new shell become as hard as the old in 24 hours, but that it usually requires from two to three days; and Chartran, referring to the same animal, says he has seen the shell resume its normal consistency in 48 hours. Vitzow admits that the carapace has become perceptibly harder in 24 hours, but that 72 hours must expire before it is completely so. It would seem that in the case of the lobster, there is a considerable variation in the time required, and that it is not marketable for at least a month.

Now, from experience, the condition of the flesh has no bearing upon its deterioration in the cans. The most that can occur is a slight alteration in the flavour or consistency of the flesh.

The Question of Size

It remains yet to consider what bearing the size, and, therefore, the age of the lobster has upon its value as a preserved food.

We have now to inquire what are the data from which the age of a lobster may be determined. The age can scarcely be determined by direct observation, since the conditions of confinement, food supply, temperature, &c., probably introduce variations which will render any conclusions fallacious. By observation, Herrick found that one yearling lobster which had been hatched from the egg measured 1 1/2 inch, while three others measured 2 inches in five months. He has constructed a table from which it appears that the increase in length after each molt is about 12 per cent of the previous length, or one-eighth, that is, an 8-inch lobster would measure 9 inches after molting. If now the number of molts and the time interval could be ascertained, some conclusions could be drawn. In another table he estimates that a 2-inch yearling lobster has molted 14 times, a 5-inch lobster 20 times, an adult lobster 10 inches long 25 times. This leads him to the conclusion that a 10-inch lobster is from 4 1/2 to 5 years old. It will be seen then that the lobster is an animal of rather slow growth.

An examination of the tissues of lobsters five or six inches long discloses nothing which makes one think them unfit for canning. The expediency of so using them is another question.

Question of Sex

We have now to consider whether the sex of the lobster has any bearing upon the deterioration of the canned product. By way of preface to this consideration, a short statement of the sexual habits of the lobster will be necessary.

There is a complete separation of the sexes. The female is smaller in size, the claws are less highly developed. The abdomen is broader and more concave. The first pair of swimmerettes is reduced in size to admit of the more complete flexing of the abdomen for the protection of the eggs.

The organs of reproduction are (1) the ovaries, consisting of two masses of tissue connected by a bridge and situated in the dorsal region, extending from the middle of the carapace to the fourth or fifth abdominal segment. Just previous to laying, the ovaries are seen filled with eggs,
which may be removed by cutting into the wall. (2) Two short tubes leading from the ovaries and opening into (3) two small slits upon the basal segments of the second pair of walking legs. (4) The receptacle for the fertilizing element of the male situated between the third pair of legs. (5) Glands which secrete a cement substance for securing the eggs, after they have been laid, to the abdominal appendages. The male lobster possesses a pair of testes, opening by ducts at the base of the last pair of walking legs, and the first pair of abdominal legs are modified as if to serve for conducting the fluid, which is inclosed in gelatinous capsules, into the seminal receptacle of the female.

The pairing of lobsters may take place at any time of the year, and apparently has no connection with the condition of the ovaries of the female. The seminal fluid can be obtained from the receptacle of the female independently of the time of laying, hatching, or even molting. The male element is stored up until needed, and retains its vitality for a very long time.

There is a conflict of evidence as to how often the lobster lays eggs, when they are laid, and how long they are carried externally.

It is quite true that lobsters may be taken at all seasons of the year, with the eggs in all stages of development, but this does not affect the main statement that, for the majority of lobsters, there is a definite breeding season. The process of laying is as follows: The eggs are extruded from the body after being carried about a year, and are fertilized by coming in contact with the spermatozoa ready stored up in the seminal receptacles of the female. The tail is folded in, and the eggs are attached to the swimmerettes by means of a cement substance secreted in special glands, and there carried for about ten months. The lobster is now said to be in "berry." Then the embryos escape as free swimming animals in the ocean. The number of eggs is very large, a twelve inch lobster producing about fifteen thousand. Seeing, then, that the female lobster spends the most of its time in the business of reproduction, it is very important to decide its value as a food supply, especially since the number of males and females is probably equal.

First, lobsters can never at any period of life be compared with fish bearing their roe, because the eggs ripen over a period of two years, and there is no spawning time comparable in point of intensity with that which obtains in the case of fish.

In the report of the English Fish Commission presented in 1877, it is stated that evidence adduced is the fictions of fishermen and cooks. The fishermen wished to continue catching the female fish, and the cooks lusted after the eggs for the garnishing of salads. One witness remarked with the real fisherman's wisdom "lobsters in berry are worth twice as much as any other, the spawn is bruised and put into sauce and makes better sauce than the lobster itself. In salads it is boiled and sprinkled over the salads; it is a capital article of food. The cooks will not have the lobsters without spawn." Upon such information as this, and with logic like a fisherman's the Commissioners are led to remark "it would be as illogical to prohibit the taking of lobsters in berry as to prohibit the taking of full herring."

On the other hand, Herrick shows that a lobster in berry is actually lighter than a female not carrying external eggs, by an average of 1.63 ounces.
In the case of smaller lobsters, the difference was found to be only a tenth of an ounce. The males are heavier than the females, but this is due to the larger size of the claws. The matter was put to the test, and as between a male lobster, a female in berry and a female carrying no external eggs, the most delicate palate can detect no difference in the flesh. Lastly, there is no difference in the tendency to deterioration after canning between these three classes.

Examination of Tissues

To arrive at a conclusion as to whether lobster tissue was in normal or pathologic condition, it was necessary first to make a preliminary study of a large number of animals to be used by way of comparison. These observations were confined principally to the muscular tissue and to the blood. A detailed account of this division of the work would be out of place here; and only so much introduced as is necessary for the main purpose.

The Blood

A number of good-sized animals were secured, and by means of a deep puncture through the membrane connecting the second and third joints of the crushing claw, the blood was allowed to escape, as it did in a considerable quantity. The amount depends upon the size of the animal and the thoroughness with which the operation is done. As the blood issued it was slightly viscous, but soon coagulated into an opalescent clot, in thin layers transparent, but when seen in sections of considerable thickness, opaque, from the presence of flaky masses. From the instant of shedding, a bluish coloration appeared on the surface, at first light blue, then of a rich indigo tint. This color extended downward into the substance of the clot in a regular layer of about one-third its thickness, and after a time the whole mass changed to the same colour, with the exudation of a dark-coloured serum.

This colour disappears on heating to 100° C. in a water bath, also by the addition of hydrochloric acid or hydrogen peroxide, leaving the cloth opaque and of a pearly lustre. When further heated it assumes a brown hue, which, however, is limited to the surface. The blue colour does not return on cooling if the clot be protected by water, but on exposure to air, there is a slight reappearance. The colouring matter is not soluble in chloroform, ether or peroxide of hydrogen, nor upon spectroscopic analysis does it yield any absorptive bands, though there is a general dimming of the whole spectrum. This colouring matter is a respiratory pigment haemacyanogen and well deserves further study. The microscopic examination of the blood which was made with ×2 objective and a No. 4 ocular revealed white blood corpuscles much larger than those of the mammalia, with round sharply defined margins, or irregular with sinuous edges. The protoplasm granular and staining faintly with methylene blue, the nuclei salient either simple or compound with well defined nuclear membrane and staining deeply. In many cases, the cells were multinuclear. The blood also showed fibrin threads and granules, but no appearance of coloured corpuscles or micro-organism.

The Muscle

The muscle substance is composed of fibres in bundles, as in the case of the crab, the bundles separated by fibrous connective tissue, the fibres
striated showing alternate dim and light stripes, in this respect also resembling the muscle of the crab, but much broader than in the mammalian muscle. In the physiologically extended fibre, the light stripe is almost as broad as the dim stripe. In the centre of the light stripe, there is a well marked line or membrane known as Dobie’s line or Krause’s membrane. This line seems to consist of a row of granules. On each side of Dobie’s line and midway between it and the border of adjacent dim stripes is another faint line corresponding with the lateral disc of Engleman.

In fully contracted fibres the light stripe is much narrower than the dim one. The centre of the dark stripe appears comparatively clear and reveals the presence of a membrane like Henson’s membrane in the dark stripe of the crab’s muscle.

Besides the transverse striation there is a longitudinal striation due to the presence of fibrilles. Histologically then, the muscle of the lobster is almost identical with that of the crab.

**Epidermis**

The epidermis covering the surface, and from which the shell is secreted, is composed of epithelial cells, containing a pigment soluble in ether, and chloroform. On evaporation of the ether, an oily residue remains pigmented red, which when combined with alkalies forms a soap.

**Description of Present Methods**

It will be necessary to give some small description of the methods at present employed in the lobster packing industry. It should be said in the outset that those engaged in the industry are using their best efforts to secure satisfactory results and that any failure is due to causes entirely beyond their knowledge, and all those with whom we came in contact showed a disposition to do everything in their power to forward the investigation. At the same time, in many cases the wonder is not that the canned product is so bad, but that it is as good as it really is. Many of the factories are mere hovels with inadequate appliances for ordinary cleanliness, and under the best conditions it is to be remembered that the quantity and kind of offal connected with the process is admirably suited for the growth of putrefactive micro-organisms. The factories are seated upon the shore with stages leading into deep water for the accommodation of boats, or the buildings themselves are at the end of a stage connecting with the shore. Here the boats come laden with lobsters from the traps, and they are then counted out. They are shovelled into casks and at once thrown into a vat and boiled. The time during which they are boiled is said to be about fifteen minutes, but by actual test of many cases, we found it to be nearer half an hour when all the lobsters were out. They are then thrown upon large tables to cool, and when cool are “broken off,” that is, the body is broken from the tail, and the claws removed by striking against the side of a barrel into which they fall.

The tails are taken to the “tail table” and the meat either “punched” or “pulled.” That is, either pushed out from behind with a suitable instrument, or pulled out in front with a fork. The latter method is preferable, as otherwise the last segment of the tail is apt to be broken off. The claws are cracked and the meat shaken out; the “arms” are split longitudinally and the “arm-meat” pulled out with forks. Next the tails are split and the
APPERTIZING

97

gut removed. This splitting may be done upon the “front” or back. Front splitting is preferred since it does not interfere with the contour of the body. The blood which has coagulated in the claws in boiling is removed by washing in sea-water, and the tails are cleansed in the same way, care being taken to remove as much of the “green-gland” as possible, which in boiling has tinged the upper part of the tail. The meat is placed in strainers, and soon is ready to be packed. The cans are of two sizes, half-pound and pound; of two shapes, tall and flat. So there are “pound-flats” and “pound-tails,” “half-pound flats” and “half-pound tails.”

As the lobsters which are taken are becoming smaller year by year, it takes an increasing number to fill a can. The average now is about six to a pound.

The cans are lined on the bottom and sides with vegetable parchment of suitable shape. The tails are curled up and placed in the bottom; then comes a little arm meat, and the claws are laid in rows on top. Salt has to be added, and one has heard much discussion as to whether it should be put in first or last, whether dry or in the form of pickle. The meat is “pressed,” the can “wiped,” the paper lining is put on and finally the can is covered. The cans are now given to the sealer, and an expert workman will seal a thousand in a day. When the day’s catch is in cans, the “bathing” begins. A huge vat is filled with water and kept boiling by a fire of hard-wood in a brick furnace. The cans are placed on trays and swung in by means of a crane. The practice of packers differs, but the average length of the first bath is one hour and a half at the temperature of boiling water. The cans are hoisted out and the trays placed on a rack. Then the sealers puncture each can with a small mallet having a sharp point in its face, the steam and air rush out and then the opening is sealed. The ends of the can are now “concaved” by atmospheric pressure. This operation of puncturing the cans is variously designated, some referring to it as “probing,” others as “brobing” or even “broging,” but as philology was no part of the present inquiry, the matter is left in abeyance.

The trays are again introduced into the boiling water where they remain for another hour, and are then allowed to cool gradually. The pound cans are packed 48 in a case, and the half-pound cans 96 in a case.

For the employees, men and women, the business is not unpleasant. The work is not laborious, the pay is good, and on stormy days and wet they have good leisure to indulge their propensities, which sometimes unfortunately run in undesirable channels.

The food is abundant and good, if not very delicate, nor the cooking of it over dainty.

USE OF SALT

To preserve the characteristic flavour of the lobster, all are agreed that salt should be added, and as salt and water are cheaper than lobster, there is a further inducement for its employment. The usual amount is an ounce of pickle to the one pound can, which is included in the weight, and is, therefore, six per cent of the whole—a valuable margin of profit. In some markets the buyers specify that the meat shall be packed in dry salt. The best practice seems to be, instead of pressing the water out of the lobsters with a heavy weight, to allow them to drain by standing in perforated tins, and add the dry salt. Now, as one part of the salt is soluble in about three
parts of water, it follows that an ounce of saturated solution is equal to about a third of an ounce of salt. Two teaspoonfuls, therefore, of dry salt seems to be the proper quantity to be added to a pound of lobster.

Use of Linings

Linings of vegetable parchment were introduced four years ago as a remedy against blackening, the object being to protect the meat from contacts with the tin. The practice has led to no improvement so far as can be learned. The device is pretty; the lining gives a pleasant appearance, and as it costs less than lobster tissue, it is likely to be retained. Yet, if scorched in soldering, or if the edges slip in between the cover and the can, it is a serious disadvantage.

"Leaks" and "Do-Overs"

When the cans are removed from the first bath the ends are convex owing to the expansion of the heated air and steam within. If, however, there is a leak in the can there will be no expansion, and when punctured the can will not "blow." As soon as the can is punctured and sealed the ends are concave. Again, after the second bath, if there is a leak in any can this concaving has disappeared and is replaced by convexity. Such a can is known as a "leak." The test is applied by tapping the tops of the cans with a bit of metal, a nail or a piece of solder, and the "leaks" so discovered are set aside. This test is of very uncertain value, as the note varies with the fullness of the can, and the proximity of the contents to the cover. A number of cans which were declared by packers to be "leaks" were secured and set aside unmended. They were found to be sterile after three months. These "leaks" are then "mended" and re-bathed for half an hour. These cans are known as "Do-overs," and are considered of inferior value. Only a limited number are placed in each case. The percentage of "leaks" will depend on the care exercised in making the cans, and in the soldering of them, but the average seemed to be from three to five per cent. There seems to be no necessity for having any imperfectly sealed cans, since out of five hundred cans put up and sealed by us with only ordinary care not one turned out to be a "leak." Now, according to the principles to be afterwards laid down, if a leak should occur it is to be mended at once, and the process of "bathing" is to be commenced from the first, instead of merely boiling the can for half an hour, which, as we know, is insufficient to destroy such micro-organisms as may enter. Such a "do-over" would then be subjected to twice the ordinary amount of heat, and the contents might be injured thereby, though possibly to no great extent. Even this possibility might be avoided by care in sealing.

The Material For Soldering

Many makers have secret mixtures often purchased at great cost. As a matter of fact the use of rosin gives no additional advantage. It renders the manufacture of cans more difficult, and worst of all, the surplus rosin cannot be removed without some solvent, and it remains around the edges of the cans in a thick deposit. The result is, when the can is boiled the rosin volatilizes and permeates the tissue with its odour.

Again, shall the bottom be soldered upon the outside or the inside of the can. This is a pure matter of convenience, though in some countries there
is a regulation that all cans shall have the bottoms upon the outside on account of a whimsical belief that the danger from lead poisoning is lessened by this manoeuvre, solder being an alloy of lead and tin.

**Soldering**

It is in the soldering of the cover that the lobster packers’ fancy has an opportunity of exercising itself. Packers who were willing to yield up all their “secrets” would hesitate to reveal the nature of the “flux” they were using. Some affected to find virtue in a saturated sponge. The main thing is that whatever material be used—and there is nothing better than the ordinary “salts of lemon” it should be used in moderation, and not allowed to flow down upon the contents of the can. In many cases the copper employed was too large, and conveyed the heat to the interior of the can. The crescentic shaped soldering irons for this reason are objectionable.

**Of the Bath**

In three of the largest factories the heat is applied to the cans in iron retorts by the use of live steam. In the early part of the inquiry, as will be afterwards explained, the principles as laid down by Pasteur for the sterilization of media were applied and had to be abandoned. Upon this basis the use of steam retorts would have been invaluable. But since it is useless dealing with a temperature less than that of 100° C. the necessity for steam retorts no longer exists. The method of using the retorts at present is faulty, because too high a temperature is employed. It is the custom to introduce steam till the pressure gauge registers fifteen pounds to the square inch, and as the gauge does not begin to register till the atmospheric pressure of 14 pounds is overcome, an actual pressure above the vacuum of 29 pounds is being used. According to Regnault’s tables this is to be translated into a temperature of 248° Fahrenheit which is too high for any tissue intended to be used as food. Besides as high a temperature is disastrous to the tin. In any tin crystal the co-efficient of thermic expansion has one value in the direction of the principal axis, and another in that of the subsidiary axis. Above 213° F. they assume different values and as the crystals are oriented in a lawless fashion they tend to disintegrate. At the same time steam retorts may be used and fitted with thermometer instead of a gauge, and the steam introduced without pressure.

The following is an abstract of Regnault’s table reduced to Fahrenheit scale:

<table>
<thead>
<tr>
<th>Gauge showing lbs. per sq. in.</th>
<th>Temperature F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>212</td>
</tr>
<tr>
<td>1.3</td>
<td>216</td>
</tr>
<tr>
<td>4.3</td>
<td>225</td>
</tr>
<tr>
<td>8.3</td>
<td>235</td>
</tr>
<tr>
<td>10.3</td>
<td>240</td>
</tr>
<tr>
<td>11.3</td>
<td>242</td>
</tr>
<tr>
<td>15.3</td>
<td>250</td>
</tr>
</tbody>
</table>

**Time of Boiling in Shell**

To determine the length of time for which lobsters should be boiled the following experiment was made.

Six lobsters were placed in boiling water and one removed in five, ten, fifteen, twenty, twenty-five and thirty minutes respectively. The one first
removed was only moderately red, it could be broken off easily, but the meat was rather difficult to shake out. The lobster which was boiled for ten minutes was in perfect condition for dealing with, and all the others were unnecessarily boiled. Now it is clear that the least possible amount of boiling should be given in the shell to allow of a maximum amount of heat being applied to the can for a definite purpose, and without damaging the tissue by too prolonged application of heat. The actual time required will depend upon the size of the lobster and the thickness of the shell, but a lot of seventy was selected above the medium size and boiled for ten minutes with perfectly satisfactory results.

How long after removing the lobsters from the traps may they be allowed to remain alive before boiling?

To this question no answer can be given, because it depends upon the length of time during which they remain alive, and this depends wholly upon their surroundings, such as temperature and cleanliness.

Upon ice a lobster will live for many days and may be transported long distances, and upon a clean floor at ordinary room temperature it will live for twelve to twenty hours. But if the day be warm, if the lobsters be closely packed, especially in an unclean boat, death comes very quickly.

**USE OF DEAD LOBSTERS**

Another very important question is: May lobsters which have died before being plunged into boiling water be used for canning?

To determine this six lobsters were killed by forcibly breaking up the cervical ganglia. One was examined histologically at once and the others after four, eight, twelve, sixteen and twenty-four hours respectively, with the following results:

Lobster just dead, muscle teased out in eosin examined in Farrant’s solution 350, shows fibres with white fibrous connective tissue, striped, with Krause’s membrane and Henson’s line, healthy.

Tissue of lobster dead four hours teased in acetic acid, mounted in Farrant’s solution by 360, muscle fibres healthy.

Lobsters dead, eight, twelve, sixteen and twenty-four hours respectively, muscles in good condition, no evidence of degeneration in sarcous substance, 350 no micro-organisms. (Methylene blue, mounted in Farrant’s solution.)

Lobster sixteen hours after death, raw and boiled, tissue perfect.

Lobster dead twenty-four hours, though the tissue looks perfect, microscopically the transverse striae are rather faint, indicating that the limit of post-mortem changes has been reached. The limit of use, then, appears to be twenty-four hours at 17° C. to 20° C.

Female lobster in berry sixteen hours after death, tissue perfect.

**“BREAKING OFF ALIVE”**

It is held by many that there is great efficiency in breaking off alive, that is, separating the tail and claws before the life of the animal is destroyed by boiling. By this device the blood is allowed to escape. Now, in the first place, there is by this method a considerable loss, since a fair-sized animal yields at least four ounces of blood, yet in any case a considerable amount of blood is lost in boiling, when it appears as a coagulum about the base of
the claws and in the arms. To determine the value of this belief a number of lobsters were taken and the claws and tails separated whilst the animals were living. These were packed in cans and when opened no difference could be detected as compared with the usual method of boiling the lobsters and separating the parts afterwards.

**Parts Most Liable to Deteriorate**

To determine whether one portion of the animal is more liable to deteriorate than another, a number of cans were packed with claws alone, and others with tails alone. No difference could be observed in the results. There is always, however, even in boiled uncanned lobsters a slight brownish appearance in the “knuckle.”

**The Quality of the Tin-Plate**

There is another matter of some importance to be considered, that is, whether a saving cannot be effected in the quality of the tin plate used. For several years packers have held the opinion that much of the difficulty could be avoided by using a plate with a heavy coating of tin. Experiments were therefore made with the view of determining if the quality of the plate had any such influence. Now for the manufacture of 1,000 one-pound cans, including covers, it requires 532 sheets of tin plates 14 by 20 inches or 4½ boxes, there being 112 sheets to the box. On August 5th Bessemer Cokes were quoted at 9s. 6d. f.o.b., Swansea and Charcoals at 13s. 6d., a difference between the two qualities of 4s. a box, or 19s. per 1,000 cans. Placing the annual output of lobsters at even 200,000 cases, equal to 9,000,000 cans, the difference in cost in tin-plate alone amounts to £9,120 or about $45,000. An independent estimate based upon the price of tin-plate laid down in Charlottetown places the difference at $3.25 per 1,000 cans, equal to $31,200.

A large number of cans made of tin-plate representing these two grades were packed and careful observations made upon the results. The conclusion to which we have come upon this important matter is that no necessity exists for a very high grade of tin plate.

In the early days of the industry the material used was iron-plate instead of steel-plate as at present. Three years ago several packers, thinking the deterioration was in some way bound up with the use of steel reverted to the former practice, at a very considerable expense, but they could observe no difference in the results. Then they imported a very heavy grade of plate at a material advance in cost, but with no corresponding profit, as has already been pointed out.

**Bacteriology**

It is unnecessary to overload a report of a practical nature with technical details of bacteriologic work or dwell upon the difficulties encountered in it, because they are of a purely scientific interest and of little value to those whose first business is to pack good lobsters. Besides, it is questionable to what degree such studies should be prosecuted in a departmental inquiry. The main object was kept continually in view to provide a remedy and there would certainly be no justification in delaying the report for the sake of attaining to a scientific completeness of detail. This is the more true since the working out of these scientific requirements can be done at one’s leisure and has no heavy bearing upon the business in hand.
Only so much then is introduced as will serve to show the method of working; concerning the difficulties they are only such as are incident to all original bacteriologic inquiry. It may be noted, however, that much labour was spent upon obtaining suitable media. Many organisms refused entirely to grow upon the media usually employed and it was not until there was substituted for the ordinary peptone-gelatine and nutrient agar a preparation composed of lobster bouillon and agar, that success resulted.

An exhaustive series of plate cultures was made from a large number of cans with the object of isolating the bacteria infesting the tissue, to identify them and to study their growth and life history. Finally, four micro-organisms were obtained in pure culture. These were taken and in turn they were introduced into sterile cans, where they were allowed to grow. From these cans, again, pure cultures were obtained similar to those which were introduced. Lastly, these bacteria produced in the sterile cans conditions similar to those observed in the cans from which they were originally obtained.

Of these four micro-organisms, the statement is made provisionally, that they have not been hitherto isolated or described. The further study of these forms and the proving of this provisional statement is the scientific work referred to, for which it was not thought justifiable to further delay the present report.

The following brief account is extracted from the notes of the work done in the research laboratories of the conjoint board of the Royal College of Physicians, London, and the Royal College of Surgeons, England (January, 1897).

The organisms are named I, II, III, IV, provisionally.

Fresh inoculations were made in London with the following results:

I.

Fourth day. Gelatine tubes all show a similar growth, well marked in the whole course of the stitch, wide at the top with serrated edges, the surface slightly depressed, but no liquefaction. The growth is folded in two places. One inclined agar tube shows a faint streak, the other yields no results; the tubes are now placed in the incubator at 20° C.

Fifth day. All growths are more apparent.

Sixth day. The surface of the gelatine tube is depressed and smeared, the growth has descended leaving a transparent ovoid filmy body 1 cm. long which connects with the main growth. The stitch is wide, the edges rough with distinct colonies and the whole growth rotated in spiral form.

Seventh day. Heavy growth in both gelatine tubes, the globule at the top is now conical at the edges of the stitch, the colonies are discrete. No liquefaction of gelatine. Both agar tubes show distinct though fine growth.

Eighth day. Heavy growth, surface extension, with distinct edge and glistening pearly appearance. Stitch much expanded, filmy and tubular at top, quite transparent. One-quarter way down, the growth is opaque and dense, becoming filmy again and finally dense in the lower quarter. The end is pointed and the edge serrated; agar tubes show discrete, white moist colonies.

Ninth day. Surface growth extended and moist; two-thirds of the stitch is expanded, tubular and filmy; the bottom very dense.
APPERTIZING

103

Tenth day. Three-fourths of the stitch are now tubular; the lower part very dense and opaque; no liquefaction.

Eleventh day. All these characteristics more marked.

Twelfth day. Gelatine liquefying, surface growth extending.

Thirteenth day. Gelatine cupped and liquefying.

Fourteenth day. Gelatine liquefied and growth diffusing throughout the tube.

Microscopic examination with No. 4 ocular and \( \frac{1}{2} \) oil immersion lens; pure culture, rods of varying length and thickness, some slightly curved and others so short as to resemble cocci. No sporulation was observed. In hanging, drop No. 1 is slowly motile with an undulatory movement.


II.

Fourth day. The gelatine tubes show a growth in the whole course of the stitch, with a rather smooth edge, the growth transparent and not liquefying. One inclined agar tube shows a faint growth. The other, none.

Fifth day. Growth more marked. Tubes placed in incubator at 20° C.

Sixth day. No surface growth; the stitch transparent, edges smooth and filmy. Agar growth very indefinite.

Seventh day. Gelatine tubes show increased growth; the edges filmy and wavy. No liquefaction.

Eighth day. The stitch is wide, the edges more undulating and filmy. No liquefaction.

Agar, very fine wide transparent growth, quite marked in both tubes.

Ninth day. Gelatine not liquefying, no surface growth; stitch retains its characteristics. Agar growth more visible.

Tenth day. Gelatine tubes; growth more marked.

Eleventh day. Cupping of surface. Agar, growing.

Twelfth day. Agar, very fine transparent colonies; confluent and glistening, gelatine, cupping of surface, no surface growth, stitch wider, wavy border with lateral offshoots which are fine and filmy. During the next three days the cupping becomes more marked, the stitch wider, the border more wavy and the offshoots prominent, but no liquefaction. The agar tubes exhibited the same characteristics.

Microscopic examination; pure culture of cocci, in chains and clusters, the chains very fine, simulating spore-forming bacteria, the clusters composed of from three individuals to a mass impossible to count.

Coagulates milk; grows in hydrogen.

III

No growth at room temperature. The tubes were placed at 20° C., where they remained for four days, when growth was visible in agar, there being ten colonies upon the surface of one tube and twelve on the other. The colonies, large and distinct, with a dark center and transparent border. The agar tubes were placed at 37° C. when the growth became very rapid, the colonies confluent, and exhibiting one wide transparent growth with sinuous borders. From this a gelatine tube was inoculated and in two days showed a distinct growth, with a wavy border, translucent, but none upon surface. In two days more, one colony appeared upon the surface of the gelatine tube and the stitch was white and dense with here
and there offsets radiating outward in long transparent points. After ten
days, the gelatine began to liquefy.

Microscopic examination: pure culture, a fine long rod, straight or very
gently curved, the individuals with no special relation to each other, but
in many cases joined end to end, to form very long, straight, and wavy
threads, at least ten times the length of the single rod. The rod shows re-
fractive bodies not to be distinguished from spores.

This organism, when examined in the hanging drop, is slowly motile
and shows a nail-shaped head, dark and round, the tail undulating slowly.
In a young growth no threads are visible. During eighteen hours, the same
hanging drop was kept under observation upon a warm stage, when end
spores appeared in nearly every rod and motion still persisted. A cover
glass preparation was made from this hanging drop, the rounded end had
lessened in size under the process of staining, but free spores were ob-
served, and some just breaking from the organism.

Coagulates milk. Grows in hydrogen.

IV.

Fourth day. Gelatine tubes show a depressed surface with pale smeared
growth. The stitch is wide above and curves to a point below, as a series of
small discrete yellow colonies in a line.

Sixth day. Surface smeared, depressed, stitch growth sunk downward,
leaving a globule at the top, joining with the stitch which tapers to a point.

Seventh day. Surface growth, glistening, radiating with distinct edges,
transparent. Stitch descending, globule becoming larger, colonies at bot-
tom, still distinct and taping to a fine point.

Eighth day. Extensive transparent growth on surface; upper part of
stitch trumpet-shaped for one-fourth of its length, remainder conical, the
bottom composed of distinct colonies.

These characteristics became more marked till the twentieth day, when
the gelatine was completely liquefied.

This organism forms gas, coagulates milk and grows in hydrogen.

Microscopic examination: pure culture, fine short rods, straight, single
or in pairs, lying at an angle with each other. No spores visible; many
cocci-like forms; of the rods, the length is almost uniform.

In hanging drop this bacillus is actively motile. The four micro-orga-

nisms were stained, mounted permanently and photographed. The tubes
were all drawn to scale in colour.

A chemical examination was undertaken to determine the products of
their growths, and up to the present there have been isolated,

Indol,
Butyric acid,
Lactic acid,
Methylamine, and dimethylamine,
Sulphured hydrogen, and carbon-dioxide.

The following observations were made incidentally. Upon the paper
linings, concretions were found; these were composed of sodium, chloride,
calcium chloride, tyrosin and epithelial cells. The jelly-like covering of
tissue in cans so much desired is due to fat tinged with pigment. Add ether, evaporate; there are left fat drops tinged with pigment and "feathery phosphate of lime." No fat crystals were obtained by filtering through a wet filter.

The Remedy

Even if as yet we were apparently no nearer to the end, namely, the providing of a remedy for all these evils, we at least had a clear view of the problem.

1. The various forms which the deterioration assumed were observed.
2. The various causes of it were ascertained.
3. The degree of dependence of one cause upon another was determined.

The case might be stated thus. The deterioration was proved to be due in the main to putrefaction, and putrefaction to be due to the operations of micro-organisms. These micro-organisms could only be destroyed by heat, but it was experienced in the past that when a sufficient heat to destroy them was employed, the tin plate also was liable to be damaged and chemical changes at once ensued which became more marked as time went on. Therefore, we now come to the main question.

What means are to be employed by which lobsters may be placed in cans with the assurance that they will retain their good qualities of flavour, texture, and appearance for an indefinite period and under all climatic conditions?

The use of germicidal fluids such as salicylates, borates and others with germicidal properties may be dismissed at once. In many cases they are poisonous and in most cases they injure the quality of the foodstuff to which they are applied. In the preservation of lobsters, such poisonous substances find no useful employment.

The only process that remains is the use of heat as a sterilizing medium, but that heat must be applied in such a way as not to injure the quality of the medium or the can in which it is contained. At the same time it must be sufficient to destroy all bacteria and their spores. The general principles underlying the sterilization of media were first enunciated by Professor Tyndall in 1878. He says: "I had several cases of survival of bacteria after four and five hours boiling. Thus far has experiment actually reached, but there is no valid warrant for fixing upon even eight hours as the extreme limit of vital resistance. Probably more extended research would reveal germs more obstinate still. An infusion infected with the most powerful resistant germs but otherwise protected against the floating matters of the air is gradually raised to the boiling point. Such germs as have reached the soft and plastic state immediately preceding their development into bacteria are thus destroyed. The infusion is then put aside in a warm place for ten or twelve hours. We then raise the infusion a second time to the boiling temperature which as before destroys all germs then approaching their point of final development. The infusion is again put aside for ten or twelve hours and the process of heating is repeated. We thus kill the germs in the order of their resistance and finally kill the last of them. No infusion can withstand this process, if it be repeated a sufficient number of times. By this method of discontinuous heating, three minutes were sufficient to accomplish what three hundred minutes continuous boiling failed to accomplish."
Professor Tyndall also pointed out that a temperature much less than 100° C. or 212° F. may suffice to destroy bacteria and it was this principle which Pasteur worked upon and to which the name of Pasteurization is applied.

A degree of heat which will destroy bacteria is entirely insufficient to destroy their spores. Many bacteria will not grow if the temperature is as high as that of the human body. Some will live at a freezing temperature while the spores of others may resist the action of boiling water for five or six hours. As a matter of fact, the packers have proved by years of costly experiments that an exposure of two hours and a half to a temperature of boiling water will not in many cases destroy all the spores which infest the lobster tissue.

Having in mind the prominent part which bacteria were proved to play, it remained to apply the principles of sterilization as laid down by Tyndall to the preservation of lobsters. This is to say, the degree of heat to be employed, the duration of the application and the number of successive exposures to destroy the bacteria. Ordinarily, this is done by heating a test-tube containing the bacteria in a water bath and noting the results. But the temperature conditions in an open test-tube are entirely different from those which one finds in a sealed can filled with a solid material. Therefore, as a preliminary measure it was necessary to determine the length of time required to raise the temperature of the contents of a sealed can to the temperature of the medium in which that can is immersed. To this end, an apparatus was constructed, consisting of a can through the cover of which a well closed at the bottom, was introduced into the interior. An air chamber was soldered on top, pierced so as to allow a thermometer to be carried down the well, which was filled with oil, into the can. The can was now filled with lobster and sealed. The apparatus was then placed in a vessel of water which was kept at 100° C.

From the table below it appears that it requires at least half an hour to raise the contents of a can to near the boiling point, allowing for radiation and imperfections in the apparatus. It would be easy to determine the time with scientific accuracy with a platinum electro-thermometer, but an instrument of this delicacy was not accessible and the above results are sufficiently accurate for practical purposes.

The following tables show the result:

<table>
<thead>
<tr>
<th>&quot;HALF-POUND FLATS&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time in Minutes</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>45</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>55</td>
</tr>
<tr>
<td>60</td>
</tr>
</tbody>
</table>
From the experiment of Pasteur, it was shown that many forms of bacteria are destroyed by a temperature of 57 °C. applied for half an hour, and that if this were repeated three times, the medium became sterile. From test-tube observation, it was observed that the bacteria of the lobster was not of so delicate a constitution and the heat with which we commenced was 80 degrees, applied three times at intervals of 24 hours. All the cans so treated were a failure. Next 85 degrees was used, this also failed. Then a temperature of 90 was employed; some of the cans so treated remain good up to the present time, while cans treated with 95 nearly all remained good. With special precautions, a temperature of 95° C., equal to 204° F., will suffice. But as it is not possible in practice to convert a lobster factory into a bacteriologic laboratory, the problem ever present was to simplify the process. If 95 was accepted as the standard, it would involve the use of the thermometers and automatic temperature regulators. If a temperature of above 100° C. or 212° F. were adopted, it would necessitate the use of autoclav retorts which very few factories possess, and which are beyond the reach of many worthy men. Therefore, all experiments were continued at a temperature of 212 degrees or that of boiling water, which yields excellent results. If it is theoretically less perfect than a temperature of 195 degrees, it is attended with no such risks as might be associated with the employment of lower temperatures. Following these lines, and acting upon the information thus gained a fresh pack was made and the observations upon sterilization resumed. It is not necessary here to mention the series of failures which led up to satisfactory results. There were four factors to consider: the degree of heat, the time of exposure and the interval between them. From a full consideration of all these, we conclude as follows in the case of pound cans:

1st. Apply the temperature of boiling water for one hour.
2nd. After 12 to 15 hours, apply the same heat for 50 minutes.
3rd. After another 12-15 hours, apply the same heat for 40 minutes.

This makes two hours and a half immersion in boiling water, but from the table it appears that it takes about half an hour each time to bring the contents of the cans to the same temperature as the medium in which they are immersed, that is, one hour and a half so that the lobster tissue has less than an hour's boiling divided into three separate periods of twenty minutes each.

4th. As a special precaution, in very warm weather, or in very badly infected localities, it is advisable to give a fourth boiling of 30 minutes at the expiration of another 12 hours.

<table>
<thead>
<tr>
<th>Time in Minutes</th>
<th>Temperature C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
<td>56</td>
</tr>
<tr>
<td>20</td>
<td>68</td>
</tr>
<tr>
<td>25</td>
<td>78</td>
</tr>
<tr>
<td>30</td>
<td>85</td>
</tr>
<tr>
<td>35</td>
<td>90</td>
</tr>
<tr>
<td>40</td>
<td>94.2</td>
</tr>
<tr>
<td>45</td>
<td>97</td>
</tr>
<tr>
<td>50</td>
<td>99</td>
</tr>
<tr>
<td>55</td>
<td>100</td>
</tr>
<tr>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>
In the case of half-pound cans, the time may be reduced to fifty minutes, forty minutes and thirty minutes. Cans treated in this way have all remained perfectly bright for 15 months, the fish is firm and white, the skin brilliantly red and the flavour as good as in fish fresh from the shell. Indeed, the only "defect" that can be pointed out is that the flesh is rather hard. This is due to the fact that it is under-boiled, and would permit of being heated again by the cook before serving. It has in fact been boiled for less than an hour.

In warm weather, the cans require to be cooled rapidly after each boiling. This can best be done by the application of ice, but a stream of cold water will do equally well. They should be kept cool by the frequent application of cold water in the intervals between boiling. Those who keep them coolest will get the best results.

Cleansing the Cans

There is very little profit in keeping the lobster tissue free from contamination, if the cans themselves are not cleansed. No cans, as they come into the factories are clean enough for use. Those which have been soldered with rosin have a layer of that substance upon the bottom. When heat is applied the rosin volatilizes and permeates the meat with its odour. Workmen have a habit of carrying the cans by placing their fingers inside and grasping four at a time. If they have been using flux and solder the stains are transferred to the bright tin.

It has been already pointed out that the best flux for making cans is acid because it is clean. If rosin has been used, the excess must be removed by turpentine. The whole inside of the can is to be thoroughly rubbed with some cleansing material such as hot soap and water, a solution of soda or perhaps best of all a cloth moistened with methylated spirits. A gallon will suffice for a hundred cases. It would be easy to arrange some kind of revolving brush which might be kept moist with the solution. The cans are next to be passed through clean, fresh water and wiped dry. Then they are to be kept clean by turning mouth down upon a clean table. The covers are to be treated in the same way.

When the meat is removed from the shell, it is to be received in pans which have previously been washed in boiling water. The claws and arms are to be washed in fresh well water, upon no account in sea water. Those who are anxious to obtain the best results, will make the last washing in water which has been boiled and cooled. The tails should be split upon the front and every trace of the gut removed; if this precaution is neglected, no good results can be expected. The meat should be gently pressed and allowed to drain quite dry, being covered over with pieces of cotton just removed from boiling water. It is then to be placed in cans, directly by hand. If a cylindrical machine is used it should be boiled immediately before using.

It is quite useless adopting these precautions unless the hands of the employees are clean, and packers who value their results, will attend to this procedure, though it may appear to be an unnecessary refinement.

Removing the Air

In the section upon sealing, it was pointed out that to facilitate the process, a small hole should be left in the cover, and that before this hole
is closed, the cover should be pressed down as closely as possible to the contents, that, in short, the can should be concave, for this is all the “concaving” the can is to receive. This can perhaps best be done by means of a lever worked by the foot.

We next come to a matter of equal importance, the removal of the air from the can after the first bath by puncturing the tin. In a word, it may be said, not only that this process is useless, but a long series of investigations proves that it is one of the main causes of deterioration. If a series of cans packed in the ordinary way be opened immediately after the second bath, the following condition may be found in nearly all cases. There is a purplish discoloration upon the inside of the cover, extending down the side in a limited area and over the inside of the bottom of the can. In marked cases, it is of an intense metallic hue and often arranged in a beautiful pattern. This discoloration appears instantly and has no connection with bacterial activity. The origin and remedy for this condition were discovered during a separate line of investigation, of which the following are details.

It is well known that some forms of bacteria thrive only in the absence of air; now, the process of probing the cans would create that very condition. If the bacteria found in the cans are of this nature, it follows that this practice merely creates the conditions favourable to their growth. To test this reasoning, a can was filled with lobster meat, it was boiled for an hour and half, it was not probed but was boiled again for another hour. When this can was opened, to test its sterility, to our gratification and surprise it was found entirely free from discoloration. It may further be said that up to that time its nature and origin had baffled every effort at analysis. This occasion, however, was seized, and to determine the conditions under which this blackening occurs the following experiments were made:

Five cans were taken and treated as follows: One was sealed empty, one was filled with distilled water, one with a saturated solution of common salt and water, one with lobster meat and another with the same material. These were numbered respectively, one, two, three, four, five. They were all boiled for one hour and a half at a temperature of 100° C., and then allowed to cool. Number five was probed and all were returned to the bath for another hour and a half at the same temperature. Upon examination, number one was found unchanged, number two was very slightly rusted where the raw edge of iron came in contact with the water, number three was more rusted, number four was unaltered, but number five, the one which had been probed, showed the discoloration above referred to.

Four hundred cans were then packed and heat applied of 100° C. for periods varying from 1½ to 3 hours, and in no case did this discoloration appear when the cans were not probed. Again, all packers state this discoloration appears only after the second bath, that is, after the cans have been probed. If then, this defect is caused by probing, as is clear, it remained to consider how cans might be packed without having resort to this practice which is universally employed.

Upon further examination of the question, no reason can be discovered for this practice. Flasks of media from which the air is not expelled are kept from putrefying in laboratories for years, if only that air is free from germs, and further, air is allowed to enter those jars with no ill effect if
only the air is filtered through cotton wool to free it from germs. Therefore, in all subsequent work, the cans were not probed and this is an essential part of the process.

The sign of deterioration most readily observed is a bulging outwards of the ends of the can. There is reason in this since this bulging is due to the accumulation within of the gases incident to putrefaction, as a result of bacterial activity. If now the cans are not probed, they will be less concave than usual and will simulate blown cans. This appearance may be reduced by pressing the cover well down in the center, before soldering the air hole. The force of this objection was anticipated, and, absurd as it may seem, to explain this appearance was one of the reasons for an extensive visit to the English market as will afterwards appear.

The old test of tapping the cans with a piece of metal has always been an imperfect one, in future it will be equally imperfect, but it will be unnecessary since no can will blow if properly packed. In any case the objection is disarmed since it is explained that no extreme degree of concavity is required. On the contrary, a highly concaved can, in future, is to be regarded as a can which will probably develop “smut.”

On the 25th of August last, the results were submitted to the Minister of Marine and Fisheries and to Professor Prince in Ottawa. It was then admitted that if lobsters could be placed upon the market of the same quality as those submitted, and if they would retain under all conditions of climate and season, the qualities therein observed of colour, texture, flavour and general daintiness of appearance, the problem would be solved. The question asked was, “Will they so keep?” and the answer, “Time alone can settle.” We have now the experience of fifteen months, and after that period no deterioration is observable.

From the time that some degree of success began to attend our efforts samples were regularly submitted to experienced packers for criticism of the quality. This examination was continued for a period of five months. The samples were found satisfactory, “if they would only keep.” To test the keeping qualities, the following procedure was adopted. A number of cans were placed in an incubator, which was kept at a temperature of 37° C. equal to 100° F. constantly for two months. The cans were shaken from time to time to imitate the conditions they would have to encounter upon a sea voyage. At the end of the test they were examined and no deterioration was observed. At the present time, cans fifteen months old were opened and no signs of alteration can be detected.

Throughout the whole inquiry, we have been guided only by facts proven to be so. We have actual evidence that cans remain in perfect condition for over a year; every day increases our knowledge as to how long they will so remain. There is, however, nothing to show that they will not remain in perfect condition for an indefinite period.

Having knowledge of the fact that a large market, and particularly the English market, is very conservative as to the introduction of new processes, the Minister of Marine and Fisheries considered it advisable that personal interviews should be had with the principal importers in England. At the same time, some bacteriological problems were to be further dealt with in the Laboratories of the Conjoint Board of the Royal College of
Physicians, London, and the Royal College of Surgeons, England, the Director of which, Dr. Sims Woodhead, afforded every opportunity for work. This portion of the work is considered in another section.

Accordingly, he directed me to proceed to London on the 15th of December, where communication was had with the High Commissioner for Canada. It is worth pausing to refer to the admirable arrangements which were effected by Sir Donald Smith and the Secretary of the Commissioner, Mr. J. G. Colmer, C.M.G. These gentlemen wrote to as many importers as could be waited upon and without exception they expressed a willingness to aid us with advice and criticism. They redeemed their promise to the fullest extent. Lack of time alone prevented me from availing myself of the co-operation of the Liverpool dealers.

Subsequent Investigations and Publications

The literature upon canning was very meager in 1900. Only a few books were available and these gave a few indefinite formulae which often purported to be the secrets of the cook room. The two journals, The Canning Trade and The Canner and Dried Fruit Packer were concerned with trade news, crops, conventions, and advertising, which was all that was available to them. The researches just cited stimulated other investigations by state experiment stations and the Department of Agriculture and which have since been expanded over a wide scale.

The first private laboratory specializing on canner's problems and practically the only one available to them was opened by E. W. Duckwall at Aspinwall, Pennsylvania, in 1903. He was also the author of Bacteriology Applied to Canning, 1899, and Canning and Preserving of Food Products, 1905. The American Can Company established a laboratory in 1906, the National Canners Association began some investigations in 1910 and organized an industry laboratory in 1913, followed by the Glass Container Association in 1919. Some canners maintain their own laboratories and the can companies employ a large corps of experts to serve their and their customer's needs in all parts of the country.

The volume of publications is keeping pace with these activities, even to specializing in certain lines, so that there is no dearth of canning literature at present.
Spoilage of Canned Corn at High Temperatures

Bronson Barlow, M.S.

The Illinois State Canners' Association maintains a research fund for canning investigations at the University of Illinois. The following article is a brief account of the progress made in these investigations during the last year. This report contains only some of the results of immediate interest to the canner. A complete report, with all technical detail, is on file in the library of the University, and an extensive publication is intended as soon as the work with the type of bacteria mentioned in this report is finished.

The work has been greatly facilitated by the kindness of Mr. McCall, of the Gibson City Canning Co., who put his experience, as well as his laboratory, entirely at our disposal. Most of the work mentioned has been carried out in this laboratory.

The spoilage of canned corn at factory A, in 1912, amounted to about 3600 cases during the first eleven days of the pack, and to practically nothing during the last seventeen days. About 3% of the total pack swelled, and during the days of spoilage the loss was 17% of the standard grade, and about 15 of the extra standard. Evidence shows that both grades were cooked at 180° F. and processed alike at 250° for 75 minutes. Cans from the same lots were used for both grades at the same time, and therefore the cans were not defective.

Practically all spoilage of canned foods is caused by bacteria, which can be seen in spoiled food by means of a microscope. In the corn from these swells bacteria were also found, but all the usual cultural methods failed to make them grow. Exactly the same conditions were found by other workers in the case of flat sours.

We visited the factory where the loss occurred and found that there was not a full flow of water for the cooling tank, and the corn came from the cooling tank so hot that the men wore gloves to protect their hands when they stacked it in the warehouse. The corn spoiled within a few days after it was canned. The canner thought that the spoilage increased toward the center of the stack, and we found this to be true. The spoilage increased gradually from 2% in the outer and cooler layers to 12% in the center of the stack. Now, the stacks are not piled up from the inside outward, but by steps in pyramid form, for the convenience of the men handling the boxes. A spoilage of 12% near the center of the stack means at least 12% of all the cans in this stack were really infected with living bacteria, but they could not grow as well in the outer and cooler layers.

To prove this, we took cans that appeared sound from this same stack and inoculated them at high temperatures, some at 140° and some at 149°, and twelve out of twenty-five swelled. Some burst and some were taken out of the incubator. Apparently sound cans from other days' pack when spoilage occurred showed like results on incubation at high temperatures. Extra standard corn packed on days when the spoilage occurred in the standard grade, showed some dormant infection, but less than the standard, namely five cans out of twenty-four swelled on incubation at high
temperature. So few cans were incubated that it is not safe to state the per cent of dormant infection in the whole pack, but the experiments show that a considerable amount of such infection existed.

We selected some slight swells from among the spoiled cans and incubated them at high temperatures, and most of them swelled tight within 24 hours, and some burst. This indicates that the bacteria were still alive. Then, we got sound cans from another factory where no spoilage had occurred and inoculated them through a puncture with a needle which had been thrust into a swelled can. We sealed the puncture with solder and incubated the inoculated cans at high temperature, and they swelled, and some burst. Tight swells generally resulted in 36 to 48 hours. To make the proof sure, we punctured and resoldered many sound cans, but did not inoculate them from spoiled cans, and upon incubation at high temperature none of them swelled. This shows that if a can of sound corn is punctured, under proper precautions, and resoldered, it remains sound. If it is punctured under the same precautions and a little corn from another sound can is put into it, it will also keep after resoldering. But if, instead of the sound corn the smallest particle of swelled corn is introduced the can will swell and eventually burst. There can be no question, then, that the swelling is caused by a living and growing germ, a bacterium which forms gas.

Forty-seven tight swells from a stack where spoilage occurred were minutely examined and over 90% were alike in every respect in which they were examined, and they, like the swells that resulted from our inoculations and incubation at high temperature. The gas was mostly hydrogen, with traces of carbon dioxide, and no acid. On opening the cans, the gas soon passed off, leaving the corn quiet. The corn had a cheesy odor and flavor, but was not sour. A man in health ate some of it without any harm resulting. Pure cultures of the bacteria that caused the spoilage were at last obtained by cutting off the air from the cultures and growing them at high temperature. Pure cultures inoculated into sound cans caused the same kind of spoilage, and the bacteria were again recovered in pure culture. This means that the same kind of bacteria and no others was found. The bacteria are long, slender, Gram-negative rods mostly joined end to end in threads.

There was no growth at temperatures below 103° F. and slow growth or none at 113° and at 124° F. At 131° and 162° F. there was good growth, but none at 180°.

Bacteria which grow at unusually high temperatures are called "thermophilic," i.e., heat-loving bacteria. Other workers have found thermophilic bacteria in hot springs, in heating manure, in soil, milk, grain, silage and foods. It has been suggested, but so far as we know it has never been proved, that thermophilic bacteria caused spoilage of canned foods.

After describing the cause of this spoilage in canned corn, we will discuss the means of preventing it. Ears of corn growing in the field are comparatively free from bacteria, but the few present multiply rapidly when ears are bruised and the kernels broken by rough handling on the way from the field to the cutters; the longer the time from field to retort, the greater is the increase of bacteria, especially if the ears are piled together and allowed to heat in wagons or in the husking shed. Ears piled together in only a small bulk were found to increase in temperature from 72-91°
in one day and to 106° in two days. In four days, the acidity increased a little in sound kernels and greatly in bruised kernels. There were no bacteria in sound kernels, but very many in broken kernels. Ears of corn piled together in large quantities showed a temperature of 93° at the surface, increasing to 116° and even 122° F. in the center of the pile. These last temperatures are within the range of growth of the thermophilic bacteria. The heating itself is not due to bacteria, but to the activity of the corn. It is a process of respiration, the resulting heat being retained by the mass. The original thermophilic bacteria may come from the dust of the fields, but probably they multiply in bruised and broken kernels when the ears are piled together and allowed to heat in wagons or in the husking sheds.

It has become customary in larger factories during the last years to test the keeping qualities of every day's run by putting a few cans of each day into an incubator. If anything is wrong with the process, it is assumed that some of the samples will spoil quickly and thus give the alarm signal. This method is doubtless to be recommended, but it failed entirely in this case, because the incubator was kept at 98°, which is the best temperature for most bacteria, but too low for the thermophilic bacteria. While the test cans in the incubator kept well, they spoiled in the stack because the inside of the stack was considerably warmer than the incubator.

We have designed an incubator for high temperatures for use in the canning factories which is easily set up and efficient in use. It can be heated with a kerosene stove or with gas or flowing steam. A supply of cold running water is necessary for its operation. By its use, the canner can quickly find out if the corn is infected with thermophilic bacteria when it enters the retort, and also when it leaves the retort. If it contains no thermophilic bacteria it will not spoil in the stack even if the cooling is not sufficient. If it is infected, the infection may not survive the process, and if it does survive, it cannot develop if the corn is cooled thoroughly. In any case, the high temperature incubator gives definite knowledge and prompt warning regarding thermophilic bacteria in corn, or other canned foods. A bulletin is now being prepared on the construction and use of this incubator, and will be distributed free upon application. Apply to the laboratory of bacteriology, University of Illinois, Urbana.

Thermophilic bacteria sometimes cause spoilage of canned corn, and the means of prevention are as follows:

Handle the ears of corn gently, to prevent bruising them, and speedily, to prevent heating and the growth of bacteria.

Process according to your usual practice, but cool more thoroughly; the cooling is a vital point in preventing this kind of spoilage which happens only when infected cans are subjected to temperatures over 100° F. for several days.

Use a thermometer and cool below 112° F. To do this some canners will have to increase the efficiency of their cooling tanks. If this cannot be done, the cooling may be completed by stacking in open order for a day and then in solid blocks. By stacking in open order we mean with air spaces between the boxes and between the rows of boxes.

It may be that flat sours are sometimes caused by thermophilic bacteria. This laboratory is working for the good of the canning industry, and we hope that our friends will work with us, whether they are canning corn,
peas or other vegetables or fruits. We should like to know of other instances of spoilage like the one reported in this paper, and especially do we want to get cans of flat sours. The sooner we get them the more good can we do in the coming season. Send cans by express, prepaid, to Bronson Barlow, Laboratory of Canning Investigations, Gibson City, Ill.

The Canner, July 24, 1913.

Flat Sours in Canned Corn

Bronson Barlow, M.S.

Report from the Canner’s Fund Investigations of the University of Illinois.

Some three months of laboratory work has now been done since our last report in The Canner, and in view of changes it is desired to report progress on the problem of flat-souring of canned corn. We have examined flat sours in canned corn, tomatoes and condensed milk, but have made progress only with the corn.

An extensive commercial spoilage due to flat-souring of canned corn has been observed at one cannery. The corn was processed 60 minutes at 240° F., followed by 10 at 250° F., and it was cooled in the upright retorts by filling them with cold water for about half an hour. The usual practice was to put the cans in boxes and pile them in somewhat open order for one day, then to pile them in solid blocks. However, this practice was not closely followed at all times. Evidence does not show whether or not the cans that went sour were stacked up hot. The process was evidently not sufficient, for the cans themselves were not defective, yet spoilage occurred, and it was all of one kind, and on two successive years. It could not be studied in the original stack, as it had all been shipped three times. The acidity was found to be high, about double that of sound corn. The bacteria that caused the souring were present in great numbers. They were Gram negative, rather long, slender rods, single or joined end to end in twos or in threads of several. No doubt it forms spores, but these were not seen in the sour corn. Inoculation from can to can was without result at high temperature and at low temperature incubation, and no doubt the bacteria were all dead.

Of that canned in 1911, only about 8 to 12 per cent were found to be flat sour. The flat sours in the pack of 1910 were very irregular, some cases showing none at all, some showing as much as 50 per cent and some 100 per cent. This indicates an irregular processing, due possibly to imperfect steam circulation in retorts or else an irregular cooling, or both, for the cans remained in their original cases. These flat sours mostly all showed one and the same form of bacteria present in great numbers. The bacteria were Gram negative, rather long, slender rods, single or joined end to end in twos or in threads, and not showing spores.
The practice of this canner in processing for 60 minutes at 240° F., followed by 10 minutes at 250°, is not the approved practice among canners. The time is short and the temperature is low. It has been determined by other workers in this laboratory that it takes 65 minutes for corn to reach 250° F. at the center of the can when the corn is filled into the cans at 180° F. Our own experiments show that serious spoilage may occur after a process of 60 minutes at 250° F. In view of the general practice among canners and our own experiments, we do not advise a process less than 75 minutes at 250° F. Corn can be sterilized with a less process, but it is better practice to leave a margin of safety. The circulation of steam in the retort is not perfect, and therefore the cans in the same retort do not receive an equally effective sterilization. Moreover, the original contamination of corn varies from hour to hour.

In two factories and on several occasions flat sours were produced by under-processing corn and incubating the cans for about 48 hours within the range of thermophilic bacteria, generally between 144° F. and 163° F. Cans containing corn heated to 175° F. and processed 35, 40, 45 and 50 minutes at 250° F., became flat sour when so incubated.

Bacteria generally of one form only were present in sour corn, and in great numbers. Inoculations from these sour cans to sound corn and incubation of the inoculated cans at the same high temperature gave flat sours. Control cans which had been processed 75 minutes remained sound and free from bacteria on incubation at high temperature. Pure cultures were not isolated from any flat sours resulting from underprocessed corn at high temperatures, but can to can inoculations with incubation at high temperatures gave flat sours.

Underprocessed corn also became flat sour at low temperatures. Large numbers of cans of corn were processed at 250° F. for 40, 42, 44, 46, 51, 53, 55 and 60 minutes, respectively, and then kept at warehouse temperature below the range of growth for known thermophilic bacteria. Up to 46 minutes all the cans spoiled and mostly over 90 per cent of them became flat sour. A process of 51 minutes or more at 250° F. yielded no swells. But after a process of 51 minutes nearly all the cans became flat sour; 53 minutes at 250° F. gave about 60 per cent, 55 minutes about 50 per cent, and 60 minutes about 40 per cent of flat sour.

Sound cans showed an acidity of about 24 acid to phenolphthalein and the sour corn about 50 acid. The bacteria present in most of the cans of sour corn were Gram negative rods of medium size, and mostly single or joined end to end in twos. Inoculations from these sour cans to sound cans and incubation at high temperatures gave no growth and no flat sours. The bacteria were usually of one form, and may often have been present in pure culture, but technical pure cultures were not isolated.

From this it appears that flat sours were produced at will in either of two ways: First, by underprocessing and incubating a short time at high temperatures, and second, by underprocessing and incubating for a long time at low temperatures. The resulting flat sours seem to be alike in several respects.

In these experiments bacteria causing flat sours were more resistant to heat than the bacteria which caused swells. It is a problem of no small human interest and significance involving the probable needless annual spoilage of great quantities of food.
Bacteria that cause spoilage in canned foods are more diverse than we know. Flat sour corn in one factory may be caused by one organism and in another factory by another, and the general statements about flat sours are to be heard with caution. One canner gave his corn the usual successful process, but stacked up the cans in solid blocks while it was still hot, and for that reason he had flat sours. His corn became liquid and he could separate the sour from the sound by shaking the cans. When he heated the cans those that were flat sour swelled slightly when hot, but became flat again in a moment on cooling a little. Another canner admits that his corn was underprocessed, but believes it was well cooled. His corn became flat sour, but did not become liquid. His flat sours swelled when he reprocessed them and remained swelled when they became cold again, As already stated, we have produced flat sours at will by underprocessing and incubating the cans at high temperatures and at low temperatures. Flat souring which resulted at high temperatures was successfully inoculated from can to can at high temperatures.

If there are many living spores present in the cans when they go into the retort, it will take longer to kill them all than if few are present. They do not die all in an instant, but if half die in one period of time at a given temperature, then half of the remainder die in the next equal period of time at the same temperature, and so on, and therefore corn grossly contaminated with living spores requires a longer process.

*The Canner*, December 25, 1913.
THE CANNING OF FRUITS

“Canned fruit is the sound product made by sterilizing clean, sound, properly matured and prepared fresh fruit, by heating, with or without sugar (sucrose) and spices and keeping in suitable, clean, hermetically sealed containers, and conforms in name to the fruit used in its preparation.”

APPLE

Pyrus malus

The apple is the first fruit to be specifically mentioned in legend and has been carried by man in all his wanderings over the earth, eastward into India and China, over Europe, to the Americas, South Africa, and the Islands of the South Seas. It has been most adaptable to new conditions, reaching its highest degree of perfection on our West Coast.

The term apple has often been used in the generic sense for fruit so that one cannot always be certain what is meant in the early writings. A good example of the persistence of such usage is seen in pineapple, the fruit of a plant in no way related to the pine tree nor to the orchard variety of fruit tree. Present usage, however, is limited to the pomaceous fruit of Pyrus malus or more properly the cultivated varieties developed from it.

The home of the apple is in western Asia and Europe or from the Caucasus to the Atlantic and the Mediterranean to Sweden. There are several species of Pyrus but as far as known Pyrus malus, a low round-headed tree with rather heavy, irregular dentate, more or less fuzzy, short stemmed leaves, is the only one which has responded to the horticulturists’ art. In the wild state the tree has a strong resemblance to the quince. The crab apples nearly all come from Pyrus baccata or Siberian crab, a more slender tree with smoother leaves and longer stems. There are two species of Pyrus in this country but neither has contributed anything to the improvement of the fruit.

The apple has been extraordinarily responsive to cultivation both with respect to the tree and fruit. The diverse modifications range from a shrub only a foot in height to trees sixty feet tall, with all the modifications from the slender to the broadly flattened globular form and in fruit from the size of a large pea to more than four inches in diameter. More than a thousand varieties have been listed in trade catalogues from which it is possible to select kinds suitable for growing under widely diverse growing conditions or for producing fruits for a particular purpose. No amount of effort has succeeded in making the tree do well where it is either very hot or very cold though it needs a fairly warm season to develop fruit of good size and

“Canned fruit is the sound product made by sterilizing clean, sound, properly matured and prepared fresh fruit, by heating, with or without sugar (sucrose) and spices, and keeping in suitable, clean, hermetically sealed containers, and conforms in name to the fruit used in its preparation.”
quality. It has been estimated that there are 500,000,000 trees under cultivation.

The fruit is generally more or less globular in shape with a depression at the stem end and since the calyx tube remains adherent to the ovary, it produces a small five-parted mark at the blossom end. The calyx tube enlarges and forms the fruit, and this develops innumerable variations in shape, size, color, markings, and flavor, in the time required for maturing and the changes after harvesting. The earliest variety which it is believed can be identified is the winesap, mentioned by Cato about 150 B.C.

The early use of the apple was in the fresh state at the time of ripening but storage for prolonging the edible period was soon recognized as being desirable. Cato describes the rooms and ventilating system by which to get cool air, how to control the amount so as to prevent withering, and the need for spreading the fruit in thin layers on clean straw. The walls of the rooms were constructed to give fairly good insulation so that one may conclude that the conditions were not very different from those found on good farms at the present time.

When the apple was carried to the north of Europe and to England, it served a double purpose: supplementing the meagre supply of native fruits and as a source for cider as a beverage and stock for vinegar. It filled the place of the grape farther south. The importance of cider may be better appreciated by the attention given to it in such books as *Vinetum Britannicum* or a *Treatise of Cider*, 1676; *Vinetum Angliae*, 1700; and *Cyder*, 1708. The colonists from Nova Scotia to Georgia had similar notions concerning its importance and many uses.

While the apple is grown in most parts of the United States except Florida and along the Gulf Coast, and in southern Canada, there are certain sections better suited for production than others. These are more particularly Nova Scotia and along the St. Lawrence River, among the White Mountains in New England, western New York, on the foothills of the mountains in Virginia, in the Ozark hills of Missouri, and in the valleys of Oregon and Washington. Some trees are grown upon nearly every farm but great commercial orchards supply the cities with fruit, while scientific handling and storage make the supply almost continuous.

**Uses**

The fruit is eaten fresh alone, in salads, cooked in various ways, especially in pies, apple-sauce, apple butter, and jelly. The fresh juice, cider, either fermented or not, is used as a beverage and after it has undergone alcoholic fermentation a subsequent acetic fermentation gives the standard table vinegar. The waste—culls, chops, press pomace, etc., is also made into vinegar and the pectin is extracted for use in producing jelly. The small residue which remains is dried for stock feed.

**Composition**

A chemical analysis does not give the apple a very high food value but it is pleasing, refreshing, and very wholesome.

The composition of the apple as given by Chatfield and McLaughlin, "Proximate Composition of Fresh Fruits," Circular 50, Department of Agriculture, is as follows:
Constituents

<table>
<thead>
<tr>
<th></th>
<th>All varieties</th>
<th>Early</th>
<th>Medium</th>
<th>Late</th>
<th>Cider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>12.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>84.10</td>
<td>86.50</td>
<td>85.40</td>
<td>83.60</td>
<td>87.10</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.10</td>
</tr>
<tr>
<td>Fat</td>
<td>0.40</td>
<td>0.40</td>
<td>0.30</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>Ash</td>
<td>0.29</td>
<td>0.30</td>
<td>0.25</td>
<td>0.28</td>
<td>0.25</td>
</tr>
<tr>
<td>Carbohydrates, total</td>
<td>14.90</td>
<td>12.50</td>
<td>13.80</td>
<td>15.50</td>
<td>12.50</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.00</td>
<td>1.10</td>
<td>0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar</td>
<td>11.10</td>
<td>9.40</td>
<td>10.40</td>
<td>11.20</td>
<td>10.50</td>
</tr>
<tr>
<td>Malic acid</td>
<td>0.47</td>
<td>0.70</td>
<td>0.45</td>
<td>0.46</td>
<td>0.52</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>64.40</td>
<td>54.80</td>
<td>59.10</td>
<td>65.90</td>
<td>50.40</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>290.00</td>
<td>250.00</td>
<td>270.00</td>
<td>300.00</td>
<td>230.00</td>
</tr>
</tbody>
</table>

Apples for Canning

The sections of country in which most apples are produced for canning are naturally where production is heaviest. The largest source is in the northwest on the Pacific Coast where the apples are large and of good quality but the distance to the fresh market is so great that there result enormous quantities of the B grade suitable for the purpose and obtainable at low cost. The foothills of Virginia have been planted to large apple orchards and there again is a surplus of B grade fruit above the average in quality. In canning, economical production depends upon a volume of good quality fruit in order that the labor of preparation be held to a minimum. Canned apples have to compete with apples in cold storage at least during five months while the latter retain their flavor, and now with frozen fruit, which is the reason for the importance of low cost of stock and of manufacture.

For canning, apples are selected for their cooking qualities, tartness, and flavor in order that the product be acceptable in the trade. Such varieties as Greenings, Pippins, Grimes Golden, Jonathan, Wealthy, Baldwin, Spitzenburgh, and Russet, the ones preferred fresh are also first choice. These varieties mature late in the season and change slowly after picking so that they can be handled after the rush work on other fruit is over and when conditions are most favorable. The fruit need not be A grade, though windfalls, culls, bruised and damaged fruit cannot be used profitably as they require too much hand trimming to get a strictly white clean pack. The stock must be at least two and one-quarter inches in diameter in order to be peeled well by machine. A grade of apple which might be accepted for fresh pie-stock or for evaporated-stock may be rejected for canning as the requirements for the latter are more rigid, and any defect is apparent in the finished product. The varieties need to be kept separate, or if mixed, should be done with caution and with the purpose of blending to get the best possible flavor. The blending of varieties makes an improvement in cider and also in apple-sauce so that it is logical to assume that the same thing occurs with sliced apples.

U. S. STANDARDS FOR CANNERY APPLES (1930)

Grades

U. S. No. 1 shall consist of apples of one variety which are not overripe; which are free from decay, worm holes, freezing injury, internal breakdown, and from any defect which cannot be removed during the usual commercial preparation for use without causing a loss of over 5 per cent, by weight, of the apple in excess of that which would occur if the apple were perfect. (See minimum size.)

U. S. No. 2 shall consist of apples of one variety which are not overripe; which are free from freezing injury, internal breakdown, and from any defect which cannot be
removed during the usual commercial preparation for use without causing a loss of
over 25 per cent, by weight, of the apple in excess of that which would occur if the
apple were perfect. (See minimum size.)

CIDERS shall consist of apples which do not meet the requirements of either of
the foregoing grades.

**Minimum Size**

The minimum size may be fixed by agreement between buyer and seller. Apples
below this specified minimum size shall be classed as CIDERS.

Though apples were one of the first fruits canned, their preparation
was treated in an indifferent manner until within the past twenty years.
They were generally packed to utilize some second grade or to fill empty
cans left over from other packing, consequently the character of the pack
was not of the kind to create demand. The apples were not selected for
uniformity or cooking quality, the cans were not properly filled with fruit,
and water was added, which naturally withdrew flavor. Moreover the fruit
possesses a peculiarity in that it contains an unusual amount of air or gas,
which being released during the cooking favors attack upon the metal of
the can, thus affecting the flavor and also inflicting serious damage by pro-
ducing springers and pinholes. Taken as a whole, past operations were not
profitable to the canner, the product was not sought by the retail dealer,
nor found satisfactory to the consumer.

**Factory Operations**

There is no standard method of delivering apples to the cannery; it may
be in boxes, baskets, barrels, bags, or loose on wagons; nor is there any
standardized method of storage; it may be in the containers used in hauling
or they may be held in bins in the factory or piled on the open ground.
Bin or pile storage is economical in space but often the bulk of fruit is
so great that slow changes take place within the tissues to the detriment
of the quality.

The first step in preparation is to give a short soaking and then a thor-
ough spray washing to remove adherent dirt, followed by inspection upon
a belt. Every apple not suitable for canning or necessitating hand work is
removed as it can be done more economically at this point than in any
subsequent operation. Grading for size is not necessary, though desirable
as it speeds up the work in peeling. The only special machine needed is the
peeler since steaming or cauterizing is not successful. These machines
impale the fruit around the core, cause it to revolve against a knife adjusted
to follow the contour and thus remove the peel, and as a final step while
the peeled apple is being disengaged, the core is neatly cut out by means
of a tube. The mechanism is power driven but the same principles with
parts of lighter construction are found in hand-operated machines. The
larger type machines are also provided with a mechanism to aid in placing
the fruit upon forks which make feeding easier and at the same time in-
crease the speed. Automatic feeders are available but are not as satisfac-
tory as hand operation. The peeled apple on being disengaged from the
machine falls on an attached roller-inspection belt where they are turned
for inspection and trimming, after which they are again placed by hand
upon a device for enlarging the cut around the seed cells, and finally sliced
into quarters or the number of pieces desired.

Formerly quarters were the style of cutting supplied to the trade, but
as slices are used in pies and the majority of the apples canned are for
that purpose, a change has been made to the latter. Quarters and halves are desired for making dumplings but these are obviously of minor consideration.

An operating unit consisting of two paring machines, a roller inspection table, and a combined seed-cell cutter and slicer, is made and recommended by one company that specializes in the manufacture of apple canning equipment. A unit requires one feeder, two trimmers, two seed-cell operators, and one inspector, or six persons working as a team, and these, provided with good stock, handle more than a hundred bushels per day. It is claimed that the quantity handled is a little higher when counters are used to record the apples peeled than if this detail be omitted; in other words, from 24,000 to 25,000 apples are handled without the counter and 28,000 when the counters are used. The waste in peeling and coring averages about 45 per cent—a little less for smooth stock and more for that which is rough. About 130 pounds of apples are required to fill one dozen No. 10 cans as solid pack.

Filling

The sliced apples are discharged into 3 per cent salt brine to be held until ready for filling into cans, the salt being used to prevent the surface from turning brown, due to an oxidase in the fruit which is acted upon by the oxygen of the air. If the salt solution be too strong or the fruit be held too long, a noticeable foreign flavor results, and excess salt increases the tendency to pinhole the can. The fruit is rinsed with plain water after leaving the brine.

If the apples be packed according to the older methods, the cans are filled with fruit, hot water or sirup added to fill the interspaces, exhausted at 180° to 185° F. for six minutes or longer, sealed, and cooked. The exhaust is made as heavy as possible without undue softening of the fruit and to that end the temperature is reduced rather than the time. A cook of 10 to 12 minutes suffices for No. 2½ cans and 20 to 25 minutes for No. 10s in an open cooker or at 200° in an agitating cooker. Plain cans are better for apples than lacquer lined as less pinholing results. The principal packing is done in No. 10 cans for hotels, restaurants, and pie bakers. A few apples are packed as quarters and halves for dumplings, care being taken not to crush them in filling the cans and the interspaces filled with a 40 degree sirup, or cider with 40 per cent sugar added. The addition of the sugar causes superficial toughening so that the apples hold their shape, and the surplus sirup or sweetened cider left from the apples can be used in sauce or other ways. The use of cider instead of water has a most wholesome effect in conserving flavor.

Solid Pack

In 1917, the so-called solid pack was originated by Harry Larkin and E. B. Cloud, Hood River, Oregon. The apples were peeled and sliced in the usual way in the shortest possible time. The fruit was steam-blanching until flexible but not sufficiently so to cause softening or mushing of the tissues. The time given was from 6 to 8 minutes at from 160° to 170° F. The temperature was held down and the time lengthened to get the maximum evacuation of gas from the fruit without undue cooking. The can was filled about one-third full with apples, then tapped on the table and a
full-sized plunger applied with moderate pressure but not to cause crushing; another layer of apples was added and the operation of tapping and pressing repeated and then a final layer to obtain a level fill. Only a few ounces of hot water could be added to a No. 10 can and that slowly to complete the fill; the water was absorbed by the fruit so that the final product weighed six pounds or more with no free liquid in a No. 10 can. The apples presented a bright appearance, with little softening or pulping of the fruit and with good natural flavor and aroma. The samples they submitted to the Quartermaster Department in 1918 were by far the best of those offered during the war period. The method marks the beginning of better apple packing and has since been reflected by the greatly increased output, reaching a total of nearly 3,500,000 cases in 1925, and 2,000,000 cases for Oregon and Washington alone in 1928 though since that time it has dropped to half that figure.

Several modifications have been made of the solid or dry pack. One is frequently referred to as the Northwestern style, the details of which, given by Prof. E. H. Wiegand, are essentially as follows: The prepared slices are dropped into cold 6 degree brine (1½ per cent) and allowed to stand from 4 to 12 hours, usually over night. During this time the pieces give up a considerable amount of gas and absorb some water. They are rinsed, then passed through a steam blancher at about 190° F., the time being from 2 to 3 minutes, or in some cases more. The object is to get the apple flexible so it can be packed tightly but not be mushy. The cans are filled immediately with from 5¼ to 5¾ pounds of fruit by weight and such quantity of water as necessary to fill the interspaces. The amount is small and taken up by the apples so that they cut out full six pounds. The cans are passed through the exhaust box to come out at a temperature of about 170° and be level full. From a perforated pipe near the end of the exhaust box, water trickles on the can until it overflows. A cook of from 18 to 25 minutes is given in an agitating cooker, followed by cooling from 6 to 8 minutes.

There are two other modifications in which hot brine is used instead of cold as it is recognized that heat hastens the exhausting of the gas from the apple. In one, the apples are dropped into brine at about 130° F. for 20 minutes to 40 to 60 minutes, then filled into cans, the subsequent steps being essentially the same as in the method previously described. In the second of these modifications the fruit is placed directly into boiling brine containing 10 pounds of salt to 100 gallons of water, boiled from 2 to 3 minutes, sprayed with water to remove any salt from the surface, filled into cans, and treated in the usual manner.

With the solid pack, cooking in an agitating cooker is almost a necessity as the heat penetration is very slow in a standing can. The apples on the outside become cooked and mushy before those at the center are sterilized.

Cooling should follow at once after cooking as it aids in preserving appearance, color, and flavor.

The criticism made on the soaking process is that the fruit looks waterlogged, suffers some loss in flavor, and shrinks in pie making.

Label Weights

The weights recommended to be declared upon the labels are as follows: Picnic—No. 1 East, 9½ ozs.; No. 300, 13 ozs.; No. 1 Tall, 14½ ozs.;
Evacuation of Air or Gas

A different scheme for getting the gas and air out of the fruit is known as the “Sellars method” and consists in placing the prepared fruit in bulk in baskets in a retort, water turned in to cover, and then the air exhausted. The gases in the tissues expand and are released while the water enters into the spaces at the time or immediately upon releasing the vacuum. Filled cans may be treated in the same way. This method gives a firm but waterlogged effect. The cans are heated in the exhaust box to 130°, and given the usual cook.

A further modification along this line is known as the “Grab method.” In this the fruit is placed in bulk in baskets in the retort, vacuumized, and while in vacuum subjected to steam for a very brief period. The steam rushes into the spaces formerly occupied by the gas. There is a certain amount of collapsing and shrinking of the tissues and thus an avoidance of the water saturation of the other two methods. The cans are filled close and given a short exhaust and cook.

Sellars Patent

The matter of both a full or solid pack and the prevention of pinholes is of so much importance that the following are quoted from Patent No. 1,279,379, issued to W. S. Sellars, New York, New York, September 17, 1918.

One of the most serious actions on the walls of a tin container due to the presence of oxygenated gases in the head space of a can occurs in canned apples, wherein complete perforation of the metal takes place in a comparatively few months, thus completely destroying the container and contents.

My improved method completely removes the air and gas from the cells of fruits and replaces them with a liquid or syrup before the fruit is sealed in the container and processed, and consequently there is no air or gas to expel from the fruit cells during processing and consequently no shrinkage after cooling and every can is completely full and remains so.

I will describe my method as applied to preparing and canning apples. The fruit is prepared as is ordinarily done, and placed in a vessel together with a liquid or syrup, preferably the same liquid or syrup as will be used when cans are finally sealed; while submerged it is subjected to a vacuum. As soon as the vacuum begins to form, the air and gas contained in the myriads of cells and pores of the fruit begin to expand and pass from the fruit, out through the liquid and out of the vessel. As the vacuum increases great quantities of air are drawn from the fruit as is evidenced by the effervescence and bubbling within the vessel. As soon as the bubbling ceases the vacuum is released and the contents of the vessel are restored to atmospheric pressure, when the liquid surrounding the fruit instantly flows into every cell and pore from which air and gas were withdrawn, with the result that the submerged fruit is completely permeated with the liquid. If the fruit has been vacuumized in its permanent containers, more syrup is added, so as to completely fill the can, when it is permanently sealed and processed in the ordinary manner, after which no shrinkage within the can will take place, since there has been no air to expel from the cells of the fruit during processing.

If the fruit is to be treated in bulk, portable, open-mesh-work baskets are used; these are filled with prepared fruit and immersed in vacuum chambers containing sufficient liquid to completely cover the fruit. After vacuumizing and permeation, the baskets are removed from the treating chamber and the fruit filled into permanent containers together with a syrup to completely fill the containers, when they are sealed and processed in the regular manner, the processing, however, being shorter than ordinarily.
From the fact that each container can be completely filled with fruit and syrup or other suitable medium, and that no shrinkage occurs after processing, there is no head space left in the can which would consist in part of oxygen; therefore, the frequent pinholing of the walls of the container, above referred to, will be largely eliminated since pinholing seldom occurs below the surface of the liquid in the can.

Aside from the elimination of the deadly pinholing, other advantages accrue from the use of this process:

Apples subjected to a vacuum under the conditions related, take on a much improved appearance, having a more or less transparent look, and being much lighter and more nearly uniform in color throughout the container. Ordinarily the meat of apple oxidizes rapidly when exposed to the air during their preparation and handling prior to canning, this oxidization being greatest on the apples most freely exposed to the air; so that when finally placed within their permanent containers and sealed, the discoloration, due to this oxidization, varies in extent, some apples being browner than others. This varying color adds nothing to their appearance, but on the contrary gives them a rather dirty, dull color which, while it may not materially affect their quality, certainly affects their salability.

Every apple in a can subjected to my process takes on a bright, clear color and remains so, since the liquid completely fills the can and there is no oxidizing agent present to cause discoloration. In the preparation of apples for my process the simple precaution of placing the peeled, cored and quartered apples into cold salt water, until they go to the vacuumizing machine will arrest discoloration to such an extent that practically no discoloration appears after being vacuumized.

Another very important advantage accruing from the use of this process lies in the higher heat conductivity imparted in obtaining a proper process, in a marked diminution of time. Air is a slow conductor of heat compared to a liquid. Apples as ordinarily inclosed in cans prior to processing, containing in their cells all of their natural air and gas, require a high temperature applied for a sufficient time to bring the apples in the center of the can to the sterilizing temperature; this inclines to overheating the apples next to the walls of the cans and a breaking down of their structure. All of the heat which reaches the center apples must be conducted by the liquids, air and gases in their cells and pores. While apples subjected to my vacuumizing process, being completely saturated with the liquid syrup and having no air or gas retained in their cells and pores, will transmit heat to each other much faster and with much less resistance, and with much less tendency to break down the cell structure; in fact, the air and gas contained in the cell spaces of fruit offer the same insulation and resistance to the transmission of heat that air spaces offer to the transmission of heat in the wall of refrigerators and ice boxes, therefore, it is little wonder that packers have had difficulty in holding the fruits together and preventing destruction of their structure during the intense and prolonged heat application necessary to effect complete sterilization. This process will greatly facilitate sterilization because heat transmission will be rapid and effective and will not be retarded by any insulating medium in the cell spaces of the fruits.

Grab Patent

Patent No. 1,557,358, October 13, 1925, issued to E. G. Grab, Nashville, Tennessee, is for a process of packing apples, the essential features of which are as follows:

The peeled and sliced apples to be treated are placed in bulk in shallow baskets or trays in a retort. The only special modification of the retort is that four upright perforated steam pipes are spaced equidistant against the wall. The perforations are turned toward the baskets and are for the purpose of delivering steam to all the fruit at the same time and under exactly the same conditions so that the treatment be uniform. The retort is closed and a vacuum drawn to a fairly high degree, 28 to 29 inches; it is held for a short time and then the valve to the pump is closed. Steam is then turned on and continued until the pressure reaches about one pound then turned off and the vent valve opened. The effect of the vacuum is to draw air and gas from within the cells and intercellular spaces and the
immediate and sudden application of the steam is to cause these spaces to fill with vapor which condenses there, or to cause the tissues to collapse. The fruit undergoes material shrinkage but with no loss of flavor or other substance, and nothing drains away. The very short application of heat causes no cooking or only the slightest amount upon the surface. The retort is opened at once and the apples filled into cans as they are or are given a short chill and filled into the cans cold. The latter practice gives a slightly better appearance to the finished product. The cans are exhausted and are given a final cook the same as other solid pack apples.

Later, a special horizontal retort was designed with interior equipment. The patent is No. 1,613,452, issued January 4, 1927.

Hansen Patent

Patent No. 1,625,207, April 19, 1927, issued to O. H. Hansen, Cedarburg, Wisconsin, which contains the following:

An object of the invention is to provide an improved process of treating acidic fruits such as cherries, strawberries, raspberries, loganberries, pineapples, plums and the like in order to permanently preserve the same.

It has been found in the art of preserving fruit and other food products having relatively high acid content, that after the material has been treated by the ordinary commercial processes, and is subsequently packed in sealed metallic containers such as tin cans, the acid and the air confined within the material frequently cause chemical reactions, and generate substances which attack the metal of the containers producing so-called "pin holes" or perforations in the cans, thus exposing the material to the air and permitting the product to spoil. If the air is entirely removed prior to confinement of the material, no such perforation of the containers and consequent spoilage of the product will occur, as the presence of acid alone will not produce "pin holes."

In order to eliminate the presence of air in the material, it has heretofore been attempted to drive off the confined air by heating the material in so-called exhaust boxes, whereby the fruit was passed through a heated chamber after having been placed in the cans and before the containers were sealed. In some of these prior exhaust boxes, hot water was employed as a heating medium, but due to the limited temperatures attainable with water and the fact that uniform heating of the product could not be effected, it was practically impossible to eliminate any appreciable amount of air by this method. It has also been attempted to utilize steam as a heating agent, but the steam quickly forms a coating or crust on the exposed surface of the material and prevents the air from escaping. The use of a flame or other agency which will excessively heat the product, is also prohibitive because excessive heating of the fruit will cause it to lose its natural shape and it is extremely desirable for commercial reasons to maintain such products in their natural condition after the packing operation has been completed. Besides being ineffective air removers, the exhaust boxes of the prior art are extremely complicated and bulky occupying a great amount of space, and are also of relatively limited capacity. As most fruits are seasonable and must be quickly treated and packed when properly developed, any process of and apparatus for processing and packing which will not permit rapid treatment of large quantities of the material in an efficient manner, will not prove commercial.

It has also been attempted to ignore the presence of air and to provide metallic cans having special non-metallic internal coatings for resisting the formation of "pin holes," but the provision of the so-called enamelled cans besides being expensive, has proven an inefficient preventative for the perforating nuisance.

The present invention contemplates the provision of a simple and efficient method of rapidly treating fruit and the like for the removal of air. With the improved method, sufficient air is removed from within the substance to practically entirely eliminate danger of perforation of the cans and consequent spoilage of the material. The improved method permits rapid and efficient treatment of large quantities of the product and is capable of effective commercial exploitation with the aid of extremely simple and compact apparatus having great capacity. These and other objects and advantages of the present improvement will be apparent in the course of the following disclosure.
A clear conception of the various steps of several modifications of the improved process will be obtainable from the accompanying description and claims.

While the product treated will hereinafter be specifically designated as fruit, it will be apparent that the principles involved are generally applicable to the treatment of other acidic edible substances. The term can as used herein is intended to define any container which is capable of being perforated by chemical reactions such as herein referred to, and should not be construed to designate only tin cans such as are ordinarily employed. The term syrup as used herein is intended to cover any liquid including brine and water.

In accordance with one form of the improved process of preserving fruit, the fruit is first properly prepared for packing, by washing, pitting or otherwise treating. After such initial preparation has been effected, desirable batches of the fruit are placed in the successive cans having upper open ends. The open ends of the successive fruit-laden cans are then temporarily closed after which the can interiors are connected to an air exhauster which withdraws substantially all of the confined air from within the fruit cells and the can. When a substantial vacuum has thus been established within the can and its charge steam is admitted to the can and immediately submerges the fruit in liquid. The liquid positively prevents subsequent ingress of air and the temporary closure may then be removed and replaced by a permanent one. The cans thus completely filled with fruit which was preliminarily sterilized by the steam previously admitted, are ready for subsequent complete sterilization or further treatment in the usual manner.

By admitting steam or other heated inert gas to the evacuated fruit cells prior to admitting the syrup or liquid, the fruit is effectively preliminarily sterilized and preserved. Any desired method of final sterilization may obviously be employed, after the fruit cells have been properly conditioned by internal heating and are subsequently filled with the liquid. The syrup or liquid may be admitted in either cold or heated condition, and the improved method of preservation assures complete elimination of destructive gases and consequently positively prevents subsequent formation of “pin holes” in the cans. Treatment of the fruit with the improved process, in no manner affects the appearance of the fruit and the commercial exploitation of the process may be automatically effected with simple and efficient apparatus. The apparatus may be readily installed between the ordinary filler and closing machine without sacrificing as much space as is required by the exhaust boxes of the prior art.

Crawford Patent

Patent No. 1,631,017, May 31, 1927, issued to S. L. Crawford, Rochester, New York, discloses that:

The object of this invention is to provide a new process for preserving or canning apples and other fruits, in order that they may thereafter be used for the purpose of making pies, and other similar purposes in cooking, and when so used will be of good appearance and will retain a large proportion of the original natural flavor.

Another object of the invention is to remove the air from the cellular tissue of the fruit, thus obviating the necessity of vacuumizing the fruit before being placed in the can, it being well known that if any appreciable amount of oxygen remains in the can after sealing that both a chemical and electrolytical reaction will take place due to the presence of oxygen, resulting in the can being attacked and ultimately perforated or pinholed, allowing access of air, with consequent spoilage of the contents, or discoloration of the fruit.

Another object of this invention is, by means of a short cook at high temperature.
to soften the cell walls of the fruit to the proper point to allow as much fruit to be placed in the can as possible and thus increase the drained weight.

Another object of this invention is to preserve the fruit in a syrup in order that the entire contents of the can may be used for making pies and other food products, whereas under the present practice it is usual to discard or drain off the watery juice in the cans, thus wasting the original flavor of the fruit contained in the water drained off.

In the practice of my invention the apples are first peeled and cored, or they may be simply peeled, and cored later at the time of trimming. The apples are then conveyed from the peeling machines to a tank containing approximately a 5 per cent cold water salt solution to prevent discoloration, the apples remaining in this salt solution for as long a time as may be desired. Or, the apples may be peeled and cored, then taken directly to the seed-cellars and quartered or otherwise subdivided, and may then be conveyed directly to the salt solution, after which they may be finally trimmed.

After the apples are trimmed they are then placed in open meshwork wire baskets, water is run or sprayed over them to remove the excess of salt, and they are then directly immersed in a sugar solution having a boiling point of 215 degrees F. to 240 degrees F. In any case the liquid will be at the boiling point. The more sugar that is desired in the final product the more sugar will be added to the syrup and therefore the higher will be the boiling point of the syrup in which the fruit is treated. In other words, the concentration of the sugar solution will depend upon the amount of sugar desired in the final product.

This step in the process forces the air from the cellular tissue of the fruit and the air is replaced by the cane sugar syrup which is thus absorbed in the tissue. Glucose or other sugars may be used as a substitute for cane sugar in this step if so desired.

The apples or other fruit are immersed in the boiling sugar solution from one to five minutes, depending upon the type and quality of fruit used and are then removed and filled directly into cans, which are promptly sealed, and under ordinary conditions will remain free from fermentation without further treatment. As a further precaution, however, Pasteurization may be used after the cans have been sealed up, but this is not believed to be necessary in all cases.

Due to the high concentration of sugar syrup and the short time of cooking and inasmuch as the fruit is cooked in practically its own juice, the natural flavor is retained to a marked degree. The high temperature of cooking promptly kills any foreign ferments or molds present.

The can is filled with syrup or boiling water, in order to exclude air at the top of the can, and the can is then filled. This process removes practically all air from the pores and cells of the fruit, replacing it with syrup or liquid, in which case the syrup or liquid is not thereafter absorbed in the fruit. It has been found by experience that cans filled in this manner will have practically the same amount of free syrup or liquid when opened after standing for many months as when originally sealed, whereas it usually happens in present canning practices that a considerable quantity of the water or syrup is absorbed in the fruit, replacing the air originally present, which air collects on top of the liquid after the can has been sealed up, thus increasing the air space at the top of the container, resulting in the rapid corrosion and pin-holing of the can.

It will also be understood that spices such as cinnamon, nutmeg, etc., may be added to the sugar solution. The flavor of the spices will thus be added to the flavor of the pie, etc.

Coons Patent

Coons Patent No. 1,735,526, November 12, 1929, issued to B. C. Coons, Rochester, New York, sets forth that:

The present invention relates to canned sliced apples and processes of canning the same. An object of the invention is to provide a drainless non-waterlogged can of sliced apples. Another object of the invention is to provide a can of sliced apples having the tart or natural flavor of the original apples. Still another object of the invention is to provide a solid pack of canned sliced apples free from liquid drain. A further object of the invention is to provide for canning sliced apples so that it will be unnecessary to introduce any material amount of hot liquid into the cans just prior to the sealing thereof. A still further object of the invention is to provide a can of sliced apples in which the apple pieces will, after remaining in the cans for an
extended period, still retain a large portion of their original air cells, so that when baked in pies or pastries the air will be driven out of the air cells and the air cells will be filled with the flavoring or seasoning material introduced into the pies or pastry, avoiding the flat after taste so common in canned apples.

Another and still further object of the invention is to so treat the apples before the sealing of the can that, when the can is sealed, it may, notwithstanding the size thereof, be heated at the center to a temperature of 185 degrees without causing the apple pieces to lose their original shapes. Still another and further object of the invention is to heat the apple pieces throughout their bodies to an equal temperature, so that, after the sealing, there is no readjustment of the temperatures within the can, producing swells or pin holes in the event of incomplete cooking, or requiring the sealed can to be heated to a point where the structures of the apple pieces will break down wholly or partially making an applesauce condition. A still further object of this invention is to provide a process of canning a solid packed apple without any danger of swells or pin holes.

To these and other ends, the invention consists of a novel canned sliced apple and of steps and combinations of steps in a canning process all of which will be hereinafter described and more particularly pointed out in the appended claims.

Canned sliced apples prior to this invention have been at a disadvantage as compared with fresh apples for two main reasons. The first and probably the most important of these reasons is that the canned sliced apple does not have the flavor of the fresh apple, and the second reason and one of the causes for the first objection is that, in canning the apples, it has been customary to waterlog the apple pieces before they enter the can, or to load the can with a watery tasteless liquid, adding to the cost of canning, storing and shipping, and, at the same time, water logging the apple pieces by filling their air cells with tasteless liquid which gives to the pies a watery condition and a flat taste and prevents the apple pieces, when baked in pies or pastries, absorbing the sweetening and flavoring materials introduced into the pies or pastries.

A number of species of apples, as for instance, the Greenings and the Baldwin, both grown extensively in New York State, have a tart apple flavor or taste which is considered of importance to many pie consumers. This tart taste or flavor about January 1st begins to leave a fresh apple and, when the next season’s bloom or blossom appears, has entirely disappeared. Canning processes prior to this invention have destroyed this tart apple flavor due to many causes, the main ones being the steam ing of the apple pieces during the process, and the waterlogging or filling of the air cells of the apple pieces with the tasteless liquid hereinbefore mentioned. The steaming process is generally employed for sterilizing the apple pieces and for bringing them up to the proper temperature for cooking after the cans are sealed, whereas the waterlogging of the apple pieces has been due to a number of causes.

Two processes are today in most common use among apple canners. One of these which is considered of importance to many pie consumers. This tart taste or flavor about January 1st begins to leave a fresh apple and, when the next season’s bloom or blossom appears, has entirely disappeared. Canning processes prior to this invention have destroyed this tart apple flavor due to many causes, the main ones being the steam ing of the apple pieces during the process, and the waterlogging or filling of the air cells of the apple pieces with the tasteless liquid hereinbefore mentioned. The steam ing process is generally employed for sterilizing the apple pieces and for bringing them up to the proper temperature for cooking after the cans are sealed, whereas the waterlogging of the apple pieces has been due to a number of causes.

According to the other process, the sliced apples are first steamed to sterilize them. This steaming partially removes the tart flavor. The apples are then placed in cans and just before sealing, a hot liquid is introduced to bring up the temperature of the contents of the cans and also to fill all space in the cans not occupied by apple pieces. The amount of this hot liquid introduced into a can just prior to the sealing has been considerably large with reference to the solid contents of the can, for, with this process, if the solid contents are increased beyond a certain amount with reference to the liquid contents, then on one hand, if the pieces are not cooked enough there will be developed swells or pin holes or other bacteria conditions in the can destroying the product, or on the other hand, the apple pieces must be cooked after sealing for such a length of time that they are wholly or partially reduced to an apple sauce condition. The steaming process to which the pieces are subjected before being placed in the can only heats the exterior portions of the apple pieces leaving them in a cooler condition at their centers. The pieces when placed in the can and sealed readjust their temperatures and if the percentage of solid contents is too great as compared with the hot liquid contents, the temperature of the can contents will be materially reduced.
The result is that, if the can is cooked long enough in the cooking process to bring up the center of its contents to the proper temperature for preservation, the outside pieces will be reduced to an apple sauce condition, whereas, if the contents at the center of the can are not brought to the proper temperature, then swells or pin holes will be produced, causing a complete loss of the product.

Canners had therefore decided that for successful canning by any but the vacuum process not above five and one-quarter pounds of sliced apples should be placed in a No. 10 or substantially 1 gallon can. This required the addition thereto of about one and one-half pounds of hot tasteless liquid at the time of sealing with the result that, even though the apple pieces were not waterlogged at the time of sealing, they became waterlogged in the can after a month and there also remained a liquid drain which was thrown away when the can was opened. It is apparent that canning under such conditions is wasteful because the complete capacity of the can is not used, thus requiring for canning a given amount of fruit, more cans, more crates or boxes for the cans, a greater packing expense in the way of labor, and a greater expense in shipping and storing.

According to this invention a can of sliced apples is produced which has no liquid drain; the apple pieces are not waterlogged but contain a large number of original air cells; the apple pieces still have the tart flavor when baked in pies or pastries, this flavor lasting beyond the bloom of the next season; the apple pieces are superior to fresh apples in that they give a tart flavor after the passing of the blossom period of the fresh apple of the next season; the cans can be packed solidly without swells, pin holes or apple sauce condition; a greater number of sliced apples can be placed in a given number of cans making the cost of canning and shipping less; and the apple pieces can be brought to uniform temperature throughout so there is no readjustment of the temperature in the pieces after the can is sealed.

In carrying out my invention, the apples are divided into pieces such as quarters, sixths, eighths, twelfths, etc. They are then preferably submitted to a liquid bath substantially at atmospheric temperature for a period of sixteen hours or more. This bath may have introduced therein brine or salt which will have the effect of preventing the discoloring of the apples during the canning process. The sliced apples emerge from the bath with their surface cells filled with the liquid of the bath but the interior air cells are in their natural conditions so that the pieces will, when they come from this bath, not be waterlogged. This bath has two functions, it causes the apples to hold their color and also assists in rendering the apples tough and flexible so that they may be handled without breakage.

The next step is to sterilize the apple pieces without steaming or waterlogging them and, at the same time, to bring the temperatures throughout the body of each piece up to a point where the sealing of the pieces in the container or can can be effected without danger of swells and pin holes, or without causing an apple sauce condition on the cooking operation. This result is secured preferably by automatically subjecting the pieces to a bath of hot water between 165° and 180° Fahr., to give them a preliminary heating in order to bring the temperature throughout the body of each piece to 160° Fahr., or above, the pieces being maintained in the bath for three to six minutes depending on the firmness of the fruit. This hot preheating bath does not give to the pieces a sufficiently high temperature for sealing in the can but this temperature cannot be obtained by a long bath of materially hotter water as the outside of the pieces will turn to apple sauce, so it is necessary to still further heat them in a hotter bath for a shorter period in order to bring up the temperature to the desired degree. Therefore, the pieces immediately after this preheating bath and while still substantially 160° Fahr. or above are subjected to a second hot bath preferably of water for a period of 30 seconds to a minute and a half, the temperature of the second bath being from 185° to 200° Fahr., depending upon the firmness of the fruit.

The next step is to fill each can with enough apple pieces that a minimum amount of air space is left in the container between the apple pieces. As a result, little or no liquid is required to be placed in the can to fill the air spaces and therefore, the apple pieces do not become waterlogged in the can and maintain their fresh or tart apple flavor and also retain the air cells, so that, when baked in a pie or pastry, spices and sugar will be absorbed by the apple pieces and a watery pie or pastry will not be obtained. This filling step is accomplished preferably by filling each can loosely with the apple pieces and providing above the can in a suitable hopper or funnel an additional supply. The can and the hopper are agitated after which a plunger is passed through the hopper to force the pieces into the can under pressure. The apple pieces
are capable of being forced into the can or receptacle under pressure due to the fact that the three baths have withered or toughened the pieces, making them adapted to being packed in a compact mass without material injury to the structure of the pieces. By this pressure it is possible to place in a Number 10 can from six and one-quarter to six and one-half pounds of sliced apples, and the cans are substantially filled in a solid condition so that little or no liquid is required to be placed in the can before sealing. The can should be sealed before the temperature of their contents is below 170° Fahr. The two hot baths to which the apple pieces are subjected bring the temperature of each piece throughout its body up to the desired sealing temperature without producing an apple sauce condition in the pieces. It follows, therefore, that when these pieces are assembled in a can that the entire contents of the can will have substantially uniform temperature and that there can be no material readjusting of the temperatures in the can after sealing as there would be if each piece did not have a substantially uniform temperature through its body. The cooking process which immediately follows the sealing and before the temperature of the contents are materially below 160° Fahr., but preferably above 170° Fahr., consists in submitting the sealed cans or containers to a boiling water bath for 15 to 30 minutes, as under the old process, to bring their contents to at least 185° Fahr., preferably 190° Fahr.

In using the expression "sliced apples" it is intended to cover any division of an apple and not solely in the sense of small divisions.

Gases in Apples

The gases in apples have been studied more carefully than in other fruits, the work being done in connection with the studies upon the causes of springers and perforations. It was believed that the imprisoned air or gas was responsible for the attack upon the metal base but the recent research and progress made in manufacture of the metal have made the cans far more resistant to attack and lessened the importance attributed to the air and gas in the tissues. A paper, "Experiments in Apple Packing," by B. S. Clark, Research Division, American Can Co., in Canning Age, February, 1923, is of special interest.

"This study involved a determination of the total amount of gas in samples of each variety together with the analysis of this gas to determine its composition. Eleven varieties of Michigan apples were included in the tests. The total amount of gas found in each variety and its average composition was as follows:

<table>
<thead>
<tr>
<th>Kind of Apple</th>
<th>Cu. in. Gas per lb. Apple</th>
<th>Per cent Carbon Dioxide</th>
<th>Per cent Oxygen</th>
<th>Per cent Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greening</td>
<td>7.4 (122cc)</td>
<td>14.1</td>
<td>12.8</td>
<td>73.2</td>
</tr>
<tr>
<td>Grimes' Golden</td>
<td>7.8 (128)</td>
<td>16.7</td>
<td>12.9</td>
<td>70.4</td>
</tr>
<tr>
<td>Wagners</td>
<td>8.1 (133)</td>
<td>12.0</td>
<td>16.7</td>
<td>72.3</td>
</tr>
<tr>
<td>Seek-No-Further</td>
<td>7.9 (129)</td>
<td>11.7</td>
<td>16.1</td>
<td>72.2</td>
</tr>
<tr>
<td>Bell Flower</td>
<td>9.6 (157)</td>
<td>5.3</td>
<td>17.7</td>
<td>76.2</td>
</tr>
<tr>
<td>Northern Spy</td>
<td>7.7 (126)</td>
<td>6.7</td>
<td>16.1</td>
<td>77.2</td>
</tr>
<tr>
<td>C. Red</td>
<td>7.9 (130)</td>
<td>12.7</td>
<td>13.9</td>
<td>73.4</td>
</tr>
<tr>
<td>Russet</td>
<td>7.9 (129)</td>
<td>15.3</td>
<td>12.0</td>
<td>72.6</td>
</tr>
<tr>
<td>Western Greening</td>
<td>9.8 (160)</td>
<td>6.6</td>
<td>17.6</td>
<td>75.8</td>
</tr>
<tr>
<td>Baldwin</td>
<td>7.5 (123)</td>
<td>11.1</td>
<td>10.6</td>
<td>78.3</td>
</tr>
<tr>
<td>Stark</td>
<td>7.6 (124)</td>
<td>11.9</td>
<td>8.5</td>
<td>79.6</td>
</tr>
</tbody>
</table>

"In the past, this gas has been referred to as air. Pure country air, however, is composed of about 21 per cent oxygen and 79 per cent nitrogen, and contains around five one-hundredths of 1 per cent carbon dioxide. Very badly ventilated rooms seldom have more than eight-tenths of 1 per cent carbon dioxide in the air. It follows from these analyses that the gas present in these apples is far too rich in carbon dioxide to be called air. This mixture is undoubtedly the result of natural respiration occurring in the apple itself.
“A study of these figures reveals some interesting facts. The rate at which the gas was evolved was most rapid during the first twenty minutes of soaking. This was to be expected since the rate at which the gas is driven out should be proportional to the volume of gas present in the apples. However, a peculiar condition presented itself in the case of the percentages of carbon dioxide, oxygen and nitrogen present in the gases liberated during soaking periods of 20, 40, and 60 minutes. The percentage of carbon dioxide increased with the length of time the apples were soaked, whereas the percentage of oxygen decreased at approximately the same rate. The percentage of nitrogen also decreased slightly except in one case, where an actual increase was found.”

In these experiments the soaking was done at 130° F. and all oxygen was removed within the first 20 minutes. In other experiments it was found that soaking at 120° F. gave a somewhat better appearing product, and that 130° is a little too high. Another observation was that in prolonged soaking where more salt was taken up, there was a marked increase in the number of cans in which perforation occurred.

In some New York experiments, using a 20-minute soaking period at 120° F., subsequent blanching gave the following cut-out weights:

“Experiments were made using 4-, 5-, 6-, 8-, and 10-minute periods of steam blanching in combination with a 20-minute soaking period at 120° F. Control tests were made without the use of the hot water soaking method. In addition several lots were packed with the use of hot water blanching. In some tests the apples were either dipped or sprayed with hot water after blanching, while in others they were filled into the cans as soon as possible. The apples were packed in No. 2½ cans, but the values obtained for cut-out were calculated to a No. 10 can basis, and may be stated approximately as follows:

<table>
<thead>
<tr>
<th>Cut-out weight</th>
<th>No. 10 cans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Not blanched</td>
</tr>
<tr>
<td>Steam blanched</td>
<td>4 minutes</td>
</tr>
<tr>
<td>Steam blanched</td>
<td>5</td>
</tr>
<tr>
<td>Steam blanched</td>
<td>6</td>
</tr>
<tr>
<td>Steam blanched</td>
<td>8</td>
</tr>
<tr>
<td>Steam blanched</td>
<td>10</td>
</tr>
<tr>
<td>Hot water blanched</td>
<td>10 at 180° F.</td>
</tr>
<tr>
<td>Hot water blanched</td>
<td>10 at 200° F.</td>
</tr>
</tbody>
</table>

“Cans which were packed with apples which had been either sprayed or dipped with hot water after blanching showed a lower cut-out weight than was found when the apples were filled directly into the cans.

“Regarding the quality and appearance of the product, the apples which had been packed with the use of the hot water soaking method in connection with the blanching process were judged to be the best.”

The amount of air or gases present in several fruits and vegetables has been determined by C. W. Culpepper and H. H. Moon* of the Bureau of Plant Industry. They found that a relationship exists between the specific gravity and the air content. The following pertaining to the apple is taken from their table:

The Relation of Specific Gravity to the Air Content of Different Varieties of Fruits and Vegetables.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Specific Gravity of Fruit</th>
<th>Specific Gravity of Expressed Juice</th>
<th>Per cent by Volume of Air in Fresh Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transcendent (crab)</td>
<td>0.939</td>
<td>1.051</td>
<td>12.2</td>
</tr>
<tr>
<td>Martha (crab)</td>
<td>0.918</td>
<td>1.053</td>
<td>13.5</td>
</tr>
<tr>
<td>Winesap</td>
<td>0.898</td>
<td>1.061</td>
<td>16.3</td>
</tr>
<tr>
<td>Munson (crab)</td>
<td>0.888</td>
<td>1.048</td>
<td>16.0</td>
</tr>
<tr>
<td>Stayman</td>
<td>0.861</td>
<td>1.052</td>
<td>19.2</td>
</tr>
<tr>
<td>N. W. Greening</td>
<td>0.860</td>
<td>1.045</td>
<td>18.5</td>
</tr>
<tr>
<td>Paragon</td>
<td>0.859</td>
<td>1.049</td>
<td>19.0</td>
</tr>
<tr>
<td>Delicious</td>
<td>0.841</td>
<td>1.053</td>
<td>21.2</td>
</tr>
<tr>
<td>Summer Rambo</td>
<td>0.833</td>
<td>1.046</td>
<td>21.3</td>
</tr>
<tr>
<td>Grimes Golden</td>
<td>0.830</td>
<td>1.065</td>
<td>23.5</td>
</tr>
<tr>
<td>Baldwin</td>
<td>0.824</td>
<td>1.050</td>
<td>22.6</td>
</tr>
<tr>
<td>Pumpkin Sweet</td>
<td>0.822</td>
<td>1.048</td>
<td>22.6</td>
</tr>
<tr>
<td>Fanny</td>
<td>0.820</td>
<td>1.051</td>
<td>23.1</td>
</tr>
<tr>
<td>Launette (crab)</td>
<td>0.798</td>
<td>1.056</td>
<td>25.8</td>
</tr>
<tr>
<td>Williams</td>
<td>0.769</td>
<td>1.047</td>
<td>27.8</td>
</tr>
<tr>
<td>Spice</td>
<td>0.761</td>
<td>1.042</td>
<td>28.1</td>
</tr>
<tr>
<td>Ben Davis</td>
<td>0.755</td>
<td>1.043</td>
<td>28.8</td>
</tr>
<tr>
<td>Queen</td>
<td>0.754</td>
<td>1.051</td>
<td>29.7</td>
</tr>
<tr>
<td>Yellow Transparent</td>
<td>0.752</td>
<td>1.042</td>
<td>29.0</td>
</tr>
</tbody>
</table>

The effect of various methods of exhausting in canning is also shown in the following from the same work:

"Specific Gravity of Different Varieties of Apples Before and After Exhausting in Different Ways.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Sp. G. of Tissue</th>
<th>Sp. G. of Juice</th>
<th>Per cent of Air</th>
<th>After 3 Minutes Exhaust</th>
<th>After Vacuum Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winesap</td>
<td>0.898</td>
<td>1.061</td>
<td>16.3</td>
<td>0.967</td>
<td>1.024</td>
</tr>
<tr>
<td>Stayman</td>
<td>0.861</td>
<td>1.052</td>
<td>19.1</td>
<td>0.976</td>
<td>1.012</td>
</tr>
<tr>
<td>N. W. Greening</td>
<td>0.860</td>
<td>1.045</td>
<td>18.5</td>
<td>0.949</td>
<td>1.020</td>
</tr>
<tr>
<td>Paragon</td>
<td>0.859</td>
<td>1.049</td>
<td>19.0</td>
<td>0.955</td>
<td>1.011</td>
</tr>
<tr>
<td>Delicious</td>
<td>0.841</td>
<td>1.053</td>
<td>21.2</td>
<td>0.960</td>
<td>1.001</td>
</tr>
<tr>
<td>Grimes Golden</td>
<td>0.830</td>
<td>1.065</td>
<td>23.5</td>
<td>0.946</td>
<td>1.016</td>
</tr>
<tr>
<td>Baldwin</td>
<td>0.824</td>
<td>1.050</td>
<td>22.6</td>
<td>0.935</td>
<td>1.081</td>
</tr>
<tr>
<td>Ben Davis</td>
<td>0.755</td>
<td>1.043</td>
<td>28.8</td>
<td>0.936</td>
<td>0.961</td>
</tr>
</tbody>
</table>

Effect of Different Methods of Removing the Air

Apples. Tests were made upon a number of varieties of apples after three minutes steam exhaust at 212° F., after holding in a vacuum of 25 inches for two hours, after holding in a vacuum plus three minutes steam exhaust, and after soaking over night in one per cent brine. In these tests, except where brine was used, the fruit was prepared for canning, placed in No. 2 tin cans and covered with juice pressed from another sample of the same material. In this way the specific gravity was not changed as a result of solids diffusing out of the tissues into the surrounding liquid. The results are shown in Table 2. It is noted that the specific gravity of the material increased when given these treatments. The specific gravity and the amount of air removed vary greatly in the different treatments. A three minute steam exhaust was not efficient in removing air from the tissues of the fruit, while a mechanical exhaust was more efficient, and a combination of the two was very effective. These results indicate that the specific gravity may often be used to advantage in gaining an idea of the effectiveness of the exhaust in removing the air from the tissues of
the fruit. It also indicates that differences in varieties during canning may be partly explained by the difficulty with which the air is removed from the tissues of the fruit. A general idea of the amount of air in plant tissues may be gained by merely placing the tissue in water. If the material sinks, there cannot be a very high percentage of air in the tissue. If the material appears to be very much lighter than water, special treatment may be necessary in canning the material in order to remove the air."

<table>
<thead>
<tr>
<th>Variety</th>
<th>Sp. G. by Volume</th>
<th>% of Air Exhaust</th>
<th>Sp. G. by Volume</th>
<th>% of Air Brine at Room Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winesap</td>
<td>1.055</td>
<td>0.6</td>
<td>0.923</td>
<td>13.8</td>
</tr>
<tr>
<td>Stayman</td>
<td>1.036</td>
<td>1.6</td>
<td>0.976</td>
<td>13.8</td>
</tr>
<tr>
<td>N. W. Greening</td>
<td>1.054</td>
<td>0.0</td>
<td>0.902</td>
<td>14.3</td>
</tr>
<tr>
<td>Paragon</td>
<td>1.036</td>
<td>1.3</td>
<td>0.914</td>
<td>13.5</td>
</tr>
<tr>
<td>Delicious</td>
<td>1.060</td>
<td>0.0</td>
<td>0.874</td>
<td>17.9</td>
</tr>
<tr>
<td>Grimes Golden</td>
<td>1.044</td>
<td>2.1</td>
<td>0.882</td>
<td>18.3</td>
</tr>
<tr>
<td>Baldwin</td>
<td>1.052</td>
<td>0.0</td>
<td>0.864</td>
<td>18.6</td>
</tr>
<tr>
<td>Ben Davis</td>
<td>1.030</td>
<td>1.3</td>
<td>0.802</td>
<td>24.1</td>
</tr>
</tbody>
</table>

In the studies reported the apple contained much more air or gas than other fruits.

**Baked Apples**

Baked apples have also been packed but the trouble in preparation has been too great to make them profitable. For this purpose smooth, rather small apples are selected so that two can be put in a No. 2 can or four in a No. 2½ can. They are well cleaned and the core removed by cutting into the blossom end but not through to the stem end, and the peel removed about one-third of the distance back from the blossom end. Sugar and spices are placed in the core space and the apple baked in a moderately hot oven until about one-third done. They are then packed into the cans. The individual apples may be wrapped in parchment paper as an extra precaution to hold their form. The interspaces are filled with 30 degree sirup, or if the apples are tart, 40 degrees. They are exhausted and cooked 12 minutes.

A recent patent, No. 1,662,044, March 6, 1928, issued to G. O. Sanborn, Los Angeles, California, is of interest in this connection.

Prior to the present invention attempts have been made to can baked apples as a commercial product which have met with little or no success, and attempts to market baked apples in cans containing a plurality of the fruit en masse have failed for the reason that the apples become mushed and converted into sauce and thereby lose their identity. This mushing of the baked apples is due to the soft character of the baked fruit which renders it susceptible to being readily disintegrated when packing in the can and on subjecting the cans containing same to agitation incident to handling and transportation of the cans. The packaging of single baked apples in individual cans for marketing has been done heretofore in a small way, but has proven not commercially practical because of prohibitive cost.

The purpose of the present invention is to provide a means and method whereby a plurality of baked apples and similar products may be packed in a single container with the individual articles so separated from each other as to prevent their being disrupted, or mushed, or converted into a sauce, and whereby on removing the articles from the container they will practically retain their original shape or contour and be of pleasing appearance thus preserving their identity and retaining their essential characteristics and also enabling their being served individually.

In carrying the invention into effect as applied to baked apples, the apples preferably unpeeled and cored, but not necessarily so, are baked in an approved manner, being
usually baked in a temperature of approximately 300°F Fahrenheit for from thirty to forty minutes. This baking operation is such as not to effect disintegration of the fruit so that the latter will substantially retain its original shape and will have the character of baked apples as ordinarily produced. The baked apples are then placed in individual receptacles that are in general of a cup shape in form, as shown in Fig. 5, and are preferably made of paper or other suitable fibrous material having such rigidity as to offer substantial resistance to crushing.

Apple-Sauce

Apple-sauce is the product produced by cooking and reducing clean, sound, fresh apples to a pulp, with or without the addition of sugar. Seasoned apple-sauce may have sugar, acid in the form of citric, lemon juice, or vinegar, and spices added to obtain a desired flavor. It has a light color, grading from white to a light straw, slightly pinkish, or tinged with brown. The color is dependent upon the character of the fruit, to the amount of exposure during preparation, and the temperature employed. Smoothness and body vary from a homogeneous thick creamy consistency to one having appreciable lumps varying in size distributed in it as affected by the cooking and the fineness of the screen used. There is no standard for consistency though commercially it is generally tested by placing a spoonful of sauce upon a plate and noting the time for liquid separation.

Apple-sauce differs from apple butter in being less concentrated and partaking much more of the fresh fruit flavor.

Apple-sauce is a relatively new commercial product though old in household use. It is only within the past fifteen years that it has been canned in any considerable quantity. The largest consumers are the public eating places and the pie bakers, the requirements being for No. 10 cans. Family consumption is showing a distinct increase which is best met with No. 1 and No. 2 cans or half-pint and pint jars.

Good apple-sauce, like any other first class product, is dependent upon the quality of the raw material, which in this case must be a good tart cooking apple with fine flavor. A sweet, dry, or tough apple is useless and cannot be made into good sauce by any amount of manipulation. Sound apples, though small, misshapen, or skin marked, and those with fresh bruises due to shaking the trees may be used if the damaged parts be removed, but stale, wilted, or rot spotted fruits are useless and labor expended upon them is thrown away. Apples of the same variety are kept together, or if mixed, it should be with the definite object of improving the flavor as may be determined by small batch tests. Late fall and winter apples are generally better for this product than the earlier varieties.

Factory Operations

The making of the highest grade of apple-sauce requires that the fruit be peeled, cored, hand trimmed, sliced, or crushed, steamed, and run through a pulper or finisher in rapid succession. Delay at any point after peeling results in oxidation with attendant browning. If it be necessary to hold the peeled and cored fruit, it is best to deliver it into closed tanks or barrels and at the same time admit steam to saturate the air and thus lessen oxidation. There is a further advantage in the steaming in that the
fruit is softened and made smoother when it passes through the pulper or finisher.

If the steaming of the fruit, either before or after crushing, has been sufficient to raise the temperature above 190° F., and steam is also admitted to the pulper or finisher, then the pulp may be drawn directly to the filling machine if it has the desired body. In case sugar or spices be added, or it be desired to effect some concentration, the pulp is drawn into a kettle, heated or concentrated while being stirred gently to get an even mixture and then drawn into the filling machine. The cans are sealed hot and given a subsequent heating of 7 minutes for small sizes and 12 minutes for No. 10s, followed by cooling. As much of the work as possible is conducted at about 190° F. instead of at boiling in order to conserve flavor.

Apple-sauce is also made by washing the fruit, steaming it until somewhat softened in a retort or open steam box, then crushing and running through a pulper. This sounds easy but is not quite so simple of accomplishment, nor is the final product as bright as in the former method.

As most of the late cooking apples are hard and do not respond to quick steaming, open cookers are not generally satisfactory. The exceptions are those varieties which soften on the tree at the time of ripening. If heated in retorts, the crates must be lined so that the fruit does not come in contact with the metal. It is best that the steam be turned on slowly so that the heat penetrates the tissues instead of scalding the surface to excess. After the fruit is well heated, it is sometimes advantageous to turn on from five to eight pounds pressure for two or three minutes to loosen the skin.

The beaters in the cyclone should be set back so as not to rub the skin to bits and force it through the screen. A thin tough skin will nearly all pass out with the tailings while one which is thick, rough, and breaks will show innumerable small specks in the pulp. A good deal of color—red, yellow, and green—will escape from the skin and affect the appearance of the pulp. The subsequent treatment of the pulp is the same as in the former method. The difference in the final product is in reality one of appearance.

Homemade Style

Homemade style apple-sauce differs from the first in that the apples are run through an Enterprise grinder having small holes, but not through a finishing machine. The pulp is kettle cooked which gives it a body with bits of solid apple throughout. It is generally spiced at the rate of 8 to 15 pounds of sugar to 12 gallons of pulp and finely ground cinnamon or nutmeg added at the rate of half an ounce for the same batch. Allspice and cloves are used sparingly. A slight tang is given by the addition of a small amount of lemon juice or vinegar, though it is not advisable to use the latter if the sauce is to be packed in tin containers. Any number of variations can be made in the flavoring but the apple should strongly predominate.

Plain tin cans are better for apple-sauce than are lacquer lined as pinholing is of less frequent occurrence. Glass is the best package for conserving flavor and especially for the smaller sizes with the sauce spiced ready for use.
UNITED STATES STANDARDS FOR GRADES* OF CANNED APPLE SAUCE

Effective January 25, 1934

Definition

CANNED APPLE SAUCE is the product from sound, fresh apples (Pyrus Malus) of proper ripeness, after proper washing, peeling, coring, pulping and processing; with or without the addition of sugar (Sucrose); packed in hermetically sealed containers, and sterilized by heat.

Grades of Canned Apple Sauce

U. S. Grade A (Fancy) canned apple sauce consists of properly screened apple pulp reduced to a heavy consistency; is of uniform good typical color throughout; possesses an evenly divided finish which may be grainy but not lumpy; is practically free from defects; possesses the typical distinct apple flavor; and scores not less than 90 points when scored according to the scoring system outlined herein; provided that no more than one factor may have a rating below 18 points.

U. S. Grade C (Standard) canned apple sauce, consists of apple pulp reduced to fairly heavy consistency; is of reasonably good color throughout; possesses a finely divided smooth finish which may be grainy; is reasonably free from defects; possesses a good apple flavor; and scores not less than 70 points when scored according to the scoring system outlined herein.

Off-Grade (Substandard) canned apple sauce is canned apple sauce which scores less than 70 points when scored according to the scoring system outlined herein, or, when any one of the grading factors falls in the subdivision D.

Prerequisites to Grading

FILL OF CONTAINER—Cans of apple sauce will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned apple sauce that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

A certificate of grade covering canned apple sauce that does not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the two-line legend,

"Below U. S. Standard—Slack Fill"
"Contains Excess Added Liquid"

The following table indicates the dimensions and names of containers most commonly in use. The last column indicates the maximum head space allowance to meet the above requirements:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum Capacity in Water at 68° F. (in ounces)</th>
<th>Maximum Head Space Allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8Z Tall</td>
<td>8.68</td>
<td>7.6</td>
</tr>
<tr>
<td>No. 1 (Picnic)</td>
<td>10.94</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>16.70</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 303</td>
<td>16.88</td>
<td>9.4</td>
</tr>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 2½</td>
<td>29.79</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>13.6</td>
</tr>
</tbody>
</table>

* These standards for grades are so framed as to exclude substances not mentioned and in each instance imply that the product is clean and sound.
Ascertaining the Grade

The grades of canned apple sauce may be ascertained by considering, in addition to the foregoing requirements, the following factors: Consistency, color, finish, absence of defects, and flavor. The relative importance of each factor has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color</td>
</tr>
<tr>
<td>II. Consistency</td>
</tr>
<tr>
<td>III. Finish</td>
</tr>
<tr>
<td>IV. Absence of Defects</td>
</tr>
<tr>
<td>V. Flavor</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

ASCERTAINING THE RATING OF EACH FACTOR—The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 18 to 20 means, 18, 19, and 20.

I. COLOR—The factor of color relates to the quality of color and its brightness and uniformity throughout the can.

(A) Apple sauce that possesses a typical, uniform, bright color throughout the can may be given a credit of 18 to 20 points, for this factor.

(C) If the color is slightly lacking in uniformity, is dull, or possesses a slightly pink or slightly brown tint, a credit of 14 to 17 points may be allowed. Apple sauce that falls in this classification shall not be graded above U. S. Grade G (Standard) regardless of the total score for the product.

(D) If the color is poor, dull, and/or possesses a pink or brown tint, a credit within the range of 0 to 13 points may be allowed.

II. CONSISTENCY—The factor of consistency deals with the density and viscosity of the product.

(A) If the product, when emptied from the can, forms into a slightly mounded mass, a credit of 18 to 20 points may be allowed.

(C) If the apple sauce flows just enough to level itself, with but a slight separation of free liquor, a credit of 14 to 17 points may be allowed. Apple sauce that falls in this classification shall not be graded above U. S. Grade C (Standard) regardless of the total score for the product.

(D) If the apple sauce is thin and watery, with a separation of considerable free liquor, a credit within the range of 0 to 13 points may be allowed.

III. FINISH—This factor refers to the evenness of finish, and its uniformity.

(A) If the finish is fine grained, the product being evenly divided, granular but not lumpy, a credit of 18 to 20 points may be allowed.

(C) If the finish lacks granular characteristics, or is somewhat pasty, a credit of 14 to 17 points may be allowed.

(D) If the finish is decidedly pasty, or contrariwise, coarse, or lumpy, a credit within the range of 0 to 13 points may be allowed.

IV. ABSENCE OF DEFECTS—The factor of absence of defects refers to the freedom from objectionable substances such as particles of seeds, flecks from bruised portions of fruit, peel, and portions of carpel.

(A) To receive a rating within the highest group, 18 to 20 points, for this factor, the product must be practically free from the defects mentioned.

(C) If the product is reasonably free from such defects, a credit of 14 to 17 points may be allowed.

(D) If the defects are decidedly prominent, a credit within the range of 0 to 13 points may be allowed.

V. FLAVOR—Consideration is given under this factor to the natural flavor and aroma of the apple sauce, and its nearness of approach to fresh apple flavor, without regard to the proportion or addition of sugar.

(A) If characteristic apple flavor is prominent and distinct, a credit of 18 to 20 points may be allowed.

(C) If the apple flavor is desirable, but not pronounced, a credit of 14 to 17 points may be allowed. Apple sauce that falls in this classification shall not be
graded above U. S. Grade C (Standard) regardless of the total score for the product.

(D) If the flavor is poor, or the product possesses an “off” flavor, such as the flavor of held or overripe fruit, a credit within the range of 0 to 13 points may be allowed.

Label Weights

The following weights have been recommended for declaration upon the label: 8Z Short, 7½ ozs.; 8Z Tall, 8½ ozs.; Picnic, No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 10 ozs.; and No. 10, 6 lbs. 11 ozs.

Davis Patent

A patent granted for an improved apple-sauce is given to show what has been done but which could not be marketed as apple-sauce under the present pure food regulations. The No. is 86,649, February 9, 1869, issued to Mr. A. R. Davis, Cambridge, Massachusetts.

The article of food commonly known as “Shaker applesauce,” is prepared by boiling cider until it has evaporated to about one-half or one-third of its original bulk and then adding apples, either green or dried, which are afterward boiled in the cider until they become tender and thoroughly saturated.

This boiling down of the cider (which is usually composed, more or less, of sweet apples) serves to concentrate its saccharine properties, and form a sirup which does not possess sufficient acidity or tartness to allow of the addition of the required amount of sweetening to preserve the sauce for a considerable length of time, or in a warm climate; and

My invention consists in the employment of tamarinds, in connection with cider and apples, the tartaric acid contained in the tamarinds uniting with the malic acid in the cider and apples, and imparting to the same an agreeable tart flavor, which will allow of the addition of a sufficient amount of sweetening to preserve it, without rendering it too sweet or insipid.

To enable others skilled in the art to understand and use my invention, I will proceed to describe the manner in which I have carried it out.

The cider is boiled down to about one-half its bulk, and the apples, either dry or green, with the skin and cores removed are then added thereto, the boiling being continued until the apples are saturated with the cider.

Next, the tamarinds are prepared as follows: To a certain quantity of tamarinds is added about half the quantity of boiling cider, which acts to soften the soluble portions, which are then passed through a sieve to remove the seeds, skins, stems, etc., leaving a soft pulpy mass. To this tamarind pulp a sufficient quantity of sugar or molasses is added, to give the required sweetening, and the tamarind pulp so sweetened is then added to the cider and apples while boiling, the whole being stirred together so as to thoroughly mix and incorporate the several ingredients.

It is evident that the proportions of the above-enumerated ingredients may be varied to suit the taste and the requirements of the case. For instance, if the sauce is intended for warm climates, more tamarinds and sweetening may be added than would otherwise be required.

By the use of tamarinds, the flavor can be made more or less tart, which is not the case where cider and apples only are employed.
Apple Jam

Apple jam was patented as a distinct article of food. It bears the number 1,262,399, April 9, 1918, issued to C. H. Simpson, Front Royal, Virginia. The description is as follows:

In general terms the invention may be stated to consist in chopping or grinding the apples into pieces with the rind attached, then cooking the chopped apples with the rind thereon to prevent the breaking down of the cells of the particles of the apple to approximately a half done condition, and then adding thereto a proper amount of sugar and continuing the cooking until the apples are well done, and terminating the cooking before the breaking down of the cells of the larger particles of apples which prevents the mass from becoming a pulp and thereby producing the formation of an apple jam.

I am aware that heretofore apple marmalade and apple butter have been common food products, but I am also aware that it has heretofore been proposed to produce an apple jam, but it has not heretofore been accomplished.

Referring now more in detail to my new method and new food product, I remove the core of the apples and cut them up in pieces, approximately quartered with the rind attached. These quartered pieces are then chopped up into smaller pieces, or passed through a suitably constructed chopper reducing the quartered portions to pieces approximately \( \frac{3}{4} \) in size with the rind attached thereto. This chopping process produces some pulp and juice and a certain amount of the pulp and juice is necessary in the mass of chopped apple to produce the proper jam consistency and to aid in cooking.

I then add a proper amount of water to the mass in approximate proportions of eighteen gallons of water to one hundred pounds of chopped apple. This water and chopped apple are then cooked to approximately a half done condition and then there is added one pound of sugar to each pound of chopped apple, depending to a great extent to the acidity of the apple. The greater the acidity the greater the sugar added.

Also at this point should be added two gallons of water to every one hundred pounds of chopped apple, or to improve the flavor and texture of the jam, cooked apple juice or fruit pectin may be added in the place of water.

If the cooked apple juice or fruit pectin is added in the place of water, an additional amount of sugar must be added depending upon the amount of water of sugar carried by the apple juice or fruit pectin. The amount of sugar carried by apple juice or fruit pectin depends upon their jellying qualities which is previously determined by experiment. This experiment is a simple method of testing the congealing point with a spoon while cooking, and depends upon the experience of the operator. The sugar must not be added until the chopped apples are cooked considerably and preferably about half done, for I have discovered that if sugar is added to the chopped apples before they are considerably cooked, it will form a coating about the larger particles of the apple producing a preserve result which would prevent the quick cooking of the apple, increasing the evaporation, and the finished product would be dry and raw in taste and would not be of a jam nature.

The temperature at which the chopped apples are cooked and the length of time they are cooked depends upon the variety of apple, the acidity thereof, and the length of cooking and the temperature is varied according to the various conditions arising from the different variety of apples and is controlled by experience, but as just stated they are cooked considerably and preferably to approximately half done, which is also determined by experience.

The chopped apples are cooked to the degree above mentioned and the sugar added. Here again the length of cooking thereafter and the degrees of heat is determined by the variety of the apple and by experience of the person doing the cooking. The heat may range from approximately 216 F., to 221 degrees but it is essential that this cooking after the sugar is added must terminate just before the breaking down of the cells of the larger particles of the apples in order to produce an apple jam product, and to prevent the mass from becoming a pulp which would produce a variety of marmalade.

In my method the rind holds the larger particles of the apple together until they are sufficiently cooked and prevents them from going to pulp. As just stated the cooking must cease before the cells of the particles break down, and this depends
again upon the variety of apples and must be determined by the experience of the cooker, as I find the temperature cannot be a guide.

The product thus produced by this method is an apple jam, and as I have heretofore stated, so far as I am aware such a product has not heretofore been accomplished. My product is characterized by the fact that the particles of the apple contain the rind thereon and that it has a viscid consistency between that of a jelly and a marmalade; that the cells of the particles of the apple are unbroken by the cooking and are distributed throughout the entire mass, thus producing a jam consistency.

In making the product known as apple marmalade, the rind is removed and the apple is cooked; sugar being added after all of the cells of the apple have been almost completely broken down by the cooking. The consistency is between a preserve and a paste, or a smooth still mass.

Apple butter is made the same way as marmalade, with the exception that cider or vinegar is used in the place of water, and it is substantially the same consistency as a marmalade.

My apple jam differs from both of the above by the facts that the apples are cooked with the rind on them; by the fact that they are cooked about approximately half done and then sugar added thereto; by the fact that it is of a viscid consistency between that of jelly and a marmalade; by the fact that the cells of the particles of apples are unbroken by the cooking, and by the further fact that the particles of apple are distributed throughout the entire mass.

**Apple Butter**

Apple butter was formerly a staple homemade conserve on a very large number of farms in the Eastern and Central States. The 50-gallon barrel of cider was the unit of manufacture. Forty gallons of the cider were first reduced to about 10 gallons, 5 to 6 bushels of apples were peeled, cored, and sliced and then boiled with the remaining 10 gallons of fresh cider. The boiled cider was added at intervals, the whole amount being evaporated to about 16 to 18 gallons. The boiling took place in open kettles with continuous stirring to prevent sticking or burning. Sugar and spices might be added a short time before completing the batch, depending upon how acid the product might be. There was considerable leeway in the amount of evaporation, that intended for use during the late fall and winter not being made nearly as heavy as that intended to be kept over into the following season.

The commercial manufacture may follow along these same general lines but more often follows that used in making apple-sauce. Cider is first evaporated to about 30 per cent of its original volume. The apples are steamed and pulped as for making apple-sauce, then evaporated in a jacketed kettle with a stirring device and as the evaporation proceeds, the cider is added. The evaporation is continued until the desired consistence is obtained. In this case eight bushels of apples can be used to a 50-gallon barrel of cider. As the cooked flavor and dark color are desired in this product, the cooking in the open and at boiling is probably an advantage. Sugar is most often added at the rate of from 15 to 25 pounds to 12 gallons of the finished product and spice to suit the taste. No standard for solids has been established, the test most often made being the same as for apple-sauce but in this instance the body is heavier.

The hot apple butter is packed in half-pint, pint, quart, and gallon jars, turned over from 15 to 20 minutes to sterilize the cap but no subsequent
process is necessary. The old style tin container was not satisfactory for this product but the new process plate has nearly eliminated erosion and pinhole difficulties and this holds for apple products in general.

**Label Weights**

The following weights have been recommended for declaration upon the labels: 8Z Short, 8½ ozs.; 8Z Tall, 9½ ozs.; Picnic, No. 1 East, 11½ ozs.; No. 300, 1 lb.; No. 1 Tall, 1 lb. 2 ozs.; No. 303, 1 lb. 2 ozs.; No. 2 Special, 1 lb. 5 ozs.; No. 2, 1 lb. 6 ozs.; No. 2½, 2 lbs.; No. 3, 2 lbs. 5 ozs.; No. 5, 3 lbs. 14 ozs. and No. 10, 7 lbs. 3 ozs.

**Cider**

Cider is the expressed juice of the apple either natural or fermented. If the term be used without qualification it is generally understood to be for the unfermented type, especially in this country. Fermented cider is commonly known as hard cider by those who produce it and as apple wine.

Cider has been used for a very long time and has had a very important place as a refreshing soft beverage, as a basis for wine or other alcoholic drink particularly where the grape was not abundant, as stock for a large proportion of the brandy, and the raw material for the standard table and culinary vinegar. Its popularity has waned due to exploiting of citrus and other juices for their health qualities, to the production of grapes by the thousands of tons for wine, and the use of less expensive materials for vinegar. Advertising and cheap transportation have aided in bringing about this change. Cider is less popular than formerly because of lack of research on how to bring up the quality and make the facts known to producers though there have been improvements in this respect since 1930. The makers lack organization to make investigations and to keep the public informed concerning the merits of their product.

Cider has been almost wholly a seasonal product, produced for a few weeks in the fall of the year or during the harvest period. It has not been a success as an all-year beverage due to failure to preserve the full flavor and at the same time have a bright clear appearance, a fault common to many fruit juices. The public will accept a cider directly from the press which will be rejected when bottled or canned, or still worse will accept an inferior synthetic drink if it be pleasing to the eye.

An essential requirement in the making of cider for beverage purposes is that it be made from clean, sound, fully ripened apples and from such varieties as yield a juice of particularly pleasing flavor. The best cider is made from apples developed and grown for the purpose but the kinds available are chiefly B grade of those produced for the fresh market. The principal source of profit from apples is in the sale of the A grade and then to use the balance in any manner as evaporated, canned, for cider, or vinegar. Aside from uniformity in appearance, size, and color, the B grade is just as good as the A for use in cider. The most serious objection is that if the harvesting be done at the same time as for market fruit, the apples will be hard ripe and therefore deficient in the mature flavor necessary for quality.
The importance of maturity cannot be over-estimated as it is through tree ripening that the sugars and esters attain their maximum with a corresponding reduction in some of the acids. Ripening develops the full bouquet and flavor which please both through odor and taste. Unripe or hard ripe fruit possess some astringency, little in some cases and much in others, and even though the taste may not seem objectionable, when drinking the juice, the desire for repetition is lessened. Blending of varieties of apples or of juices gives a better result than from a single kind and by careful study the deficiencies of one may be offset by desirable quality in another. Caldwell and his co-workers in the Bureau of Plant Industry have pointed out the fundamentals in making such blends. A lack of appreciation of the fact that cider must have an especially well developed, pleasing flavor to be satisfactory as a beverage has caused much that was suitable only for vinegar stock to be offered to the public to the detriment of the industry.

Good apples yield about four gallons of juice per bushel, or 160 gallons per ton, using the small hydraulic press with pressures from 110 to 160 pounds per square inch on the cheese or 4.5 gallons per bushel from the heavy hydraulic press exerting from 250 to 300 pounds per square inch on the cheese. Cider for beverage purposes is not pressed as heavily as for vinegar, and for the latter, the cheese may be broken and re-pressed so that the total yield be about five gallons per bushel.

Clarification

Cider intended for immediate consumption needs no treatment other than filtering and chilling, and frequently the filtering is omitted. Cider for bottling or canning must be treated to remove suspended matters such as bits of tissue, starch, and pectinous matter which coagulate upon heating or standing. Clarification and sterilization must both be accomplished within a temperature range not having an appreciable effect upon the product.

The canning and bottling of cider amounted to next to nothing prior to 1910 as most of the cider prepared for the market was preserved with benzoate of soda or other preservative. An impetus to use the canning method was given by bringing out an improved lacquer-lined can and the enforcement of the Pure Food Law. The acidity of the apple is largely due to malic acid which is much more active in its attack upon metals than most other fruit acids. Cider acquired a very marked astringent taste from the iron in the regular plain can, and the new one did not prevent this fault but delayed it for a longer time. Furthermore, pinholing was increased in the new can. What resulted was a better knowledge of sterilization, that cider could be kept when heated at a temperature below 170°F. with a much less objectionable flavor than when boiled, that subacid fruits of mixed varieties produced a cider superior to that made from one variety, and that the metal part of the machinery should be of bronze, or if of iron, it should be protected by some kind of coating.

The process which seems to have been most generally followed was to wash the fruit, crush it, press in a cheese, filter, fill in cans or bottles, exhaust, seal, and heat in a bath at 170° to 180° F. 35 minutes for No. 2½ cans or quart jars and 45 minutes for No. 10 cans or gallon bottles. The cloth bag was preferred for filtering as it did not clog as easily as other
filters and could be washed. The paper pulp filter gave best results but had too small capacity to be practical. Filter cell or diatomaceous earth was also used as an aid.

Probably the most advanced method was that described in patent No. 862,960, August 13, 1907, issued to L. Beyea, Baldwin Place, New York. The gist is that the fresh juice be strained immediately after extraction, passed through a coil set in a hot tank so that the cider be heated rapidly to 180° F., discharged upon a series of coarse cloth filters arranged one above another, filled into bottles, sealed, and heated in a bath to near 180° F.

The next step was an attempt to adopt the methods followed in clarifying grape juice to cider manufacture. The fresh pressed juice was heated to 140° by passing through a heating coil, allowing it to stand in a tank from 5 to 20 minutes, then passing through a cooling coil into a barrel which had been prepared by thorough steaming. The holding tank was not always used. The barrels were stored in a cool cellar from three to five days and the clear juice siphoned off, filled into cans or bottles, exhausted to 140° and given a bath at 150° for 40 minutes for pints or 45 minutes for quarts.

The result was a very much improved cider free from cooked flavor, but the cost for storage and labor and the waste of material combined to make this method impractical. Moreover, if the subsequent storage in a salesroom was warm some cloudiness might develop.

Filtration within the permissible range of temperature does not suffice to make a permanently bright product. Takamini, the Japanese scientist, found that by growing certain molds upon bran he could produce enzymes which would break down starches into sugar, converting the insoluble matter into soluble. This was first used as a medicinal aid to digestion but it was soon found that the technique could be used to improve the filtration and appearance of certain pharmaceutical products. The principle was applied to the clarification of fruit juices, including cider. The most practical results have come from the enzymic treatment of the latter in the purification for pectin. “Taka-diastase” and the more concentrated forms have been pretty generally known to beverage manufacturers since about 1919. A patent, No. 1,406,554, issued February 14, 1922, to A. Gusmer, is for a non-malt diastase ferment produced by the Takamine method but using Amylomyces noxii. It is not only strongly diastatic but also said to have proteolytic, fat splitting, and milk coagulating properties. A patent along the same line but using barley malt extract is appended.

In the case of cider it is the pectinous matter which causes most trouble upon standing or from heating. It was therefore important to find another enzyme which would act upon colloids to render them innocuous. This was accomplished at the New York Agricultural Experiment Station in 1927 and improved since that time. Such an enzyme is produced by several micro-organisms and in quantity by a mold, Penicillium glaucum, when grown on suitable media. Production is comparatively easy by laboratory methods and has been used in clarifying cider. The freshly pressed cider is strained through coarse cloths into tanks and the enzyme added at the rate of about one-half of one per cent, or half a pound for each 12 gallons. A concentrated preparation may be used in lesser amount. It requires
about 15 hours to get the complete action of the enzyme. The flocculence produced enmeshes the starch and bits of tissue so that by running it through a centrifugal separator and a filter, preferably of the Seitz type, the resultant juice is clear and brilliant and with full fruit flavor.

Pasteurization at 150° F. for 30 minutes for pints and quarts and for 40 minutes for gallons causes no change and suffices for protection against spoilage.

The color of the finished product, whether a pale straw or of a more golden hue will depend upon the varieties of apples used and the time of exposure of the pulp and juice. Spreading the pulp so as to get the maximum exposure to the air will result in rapid oxidation which will deepen the color.

Label Declaration (Fluid Measure)

8Z Short, 7 ozs.; 8Z Tall, 7¾ ozs.; Picnic, No. 1 East, 9½ ozs.; No. 300, 13½ ozs.; No. 1 Tall, 15 ozs.; No. 303, 15 ozs.; No. 2, 1 pt. 2 ozs.; No. 2½, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; and No. 10, 3 qts.

Concentrated Cider

Concentrated cider was patented by Gail Borden after he had received his patent upon condensed milk, the method and apparatus being the same for both.

Patent No. 35,919, July 22, 1862. Be it known that I have invented a new article of manufacture and merchandise, consisting of cider concentrated to a jelly, or at least to such a degree that it will not be liable to fermentation or injury when placed in ordinary casks and exposed for any reasonable length of time to the heat of the climate in any latitude, and I do hereby declare that the following is a full and exact description thereof.

It is well known that fermentation commences in new cider very soon after being expressed from the apple and becomes acid and soon unfit for a beverage; that in its natural state it is bulky in proportion to its value, liable to waste and deterioration, rendering it expensive and inconvenient to transport to any great distance, and thereby prevents it from becoming to any considerable extent an article of commerce. The tendency of cider to become acid has sometimes been counteracted by the introduction of foreign substances to prevent fermentation, and sometimes by placing the cider, when sufficiently fermented in glass bottles, closed or corked, to prevent the contact of air. The former of these methods renders the cider less pure and wholesome. The latter is troublesome and expensive. To obviate these difficulties I adopt means to keep cider from fermentation by concentrating it out of contact with the atmosphere as soon as possible after it is expressed from the apple to such a degree that it will not ferment when exposed to the atmosphere in any climate or in any length of time.

In order to avoid the action of the atmosphere upon the cider while boiling, I concentrate it in vacuo.

The cider may be reduced to such a degree of concentration as may be desired. I have usually reduced it to one-sixth of its original bulk, but its tendency to ferment ceases long before it reaches that degree of concentration. When concentrated, the article is similar in appearance to sugar-house sirup, and frequently with or without further heating forms a jelly, but in either state will be found proof against all influences of climate or exposure. The cider being sufficiently concentrated may be placed in common wooden casks or other vessels and transferred to any part of the world, requiring no more care than a barrel of pork or flour and not so liable to injure or deteriorate by the influence of climate as either of those commodities. The cost of transportation is so far reduced by the concentration in bulk as to justify its being carried to great distances and causing it to become a common and important article of commerce.
The cider thus condensed may be variously and beneficially used not applicable to common boiled cider.

First. It makes a most agreeable and healthy jelly (of twice the strength of ordinary jelly, and of course more nutritious) by dissolving sugar in it by heating the concentrated cider either in the vacuum pan or in a bath of hot water. The jelly may be flavored with any desirable flavoring, and put into jars, cans, or other convenient vessels.

Second. It makes a cider for a beverage by dissolving it in water in proportions to the degree of concentration, or a little more or less, to suit the taste, letting it ferment, as desired for use, in the same way as other cider, it requiring some longer time for the process. The cider thus made is superior to that made from the same kind of apple in the ordinary way. By diluting and fermenting small portions of the concentrated cider at a time any family may supply itself with this beverage from day to day in the proper stage of fermentation at all seasons of the year and in any country.

I have discovered by several trials that by dissolving the concentrated cider in a little less water than was evaporated from it, and adding a little sugar or sirup, and letting it ferment and stand (best in bottles), a very good substitute for pure wine may be obtained, which cannot be done from apples in any other way with which I am acquainted.

Cider made from the concentrated article when properly fermented in casks may be transferred into bottles in the usual manner, and will, when ripe, be found better than cider made in any other way yet known.

It is evident that by a like process the juices of grapes, currants, and various other fruits may be concentrated so as to be prevented from fermenting until diluted with water to the proper degree, and I therefore wish to include all such juices of fruits within the scope of my patent.

Having thus explained my invention, I would state that I am aware that cider has been concentrated by evaporation in open air and used for various culinary purposes, and I therefore make no claim for evaporation of cider generally.

I am also aware that various fluid substances have been and are now concentrated in vacuum under a low degree of heat, to prevent discoloration, scorching, or burning. I do not claim boiling cider and concentrating it in a vacuum for any such purpose; but I evaporate it out of contact with the air, to prevent the acidifying influence of oxygen and the hurtful change produced in boiling cider, as well as milk, when exposed to the atmosphere.

**Improvement in Cider**

**Patent No. 143,918, October 21, 1873,** issued to Mr. S. W. Mahan, Middlebury, Vermont, is for an improvement in the preparation of cider.

In making the said composition I take five gallons, for instance, of cider, as it comes from the press, and put the same into a suitable boiler, after which I mix with it two tablespoonfuls of flour and the whites and yolks of two to four eggs, first thoroughly compounding the flour and the yolks and whites of the eggs. Next, the temperature of the mixture of cider, flour, and the fluid matters of the eggs should be raised to a boiling heat, or about such, after which ten to twenty-five pounds of sugar are to be added, and the whole agitated or stirred until thorough dissolution of the sugar may have taken place. Next, the solution is to be raised to a boiling temperature and skimmed, the boiling and skimming being continued until a sufficient evaporation may have taken place to reduce the liquid to the requisite density. After this the liquid should be strained and put into bottles or suitable vessels for preserving, use, or sale.

If desirable, the product thus obtained may be flavored with any proper essence, essential oil, or matter, the whole, when completed, answering for various purposes in cookery, as well as for being eaten on bread, or of being used as a sauce for puddings.

Another patent, No. 640,289, January 2, 1900, issued to C. Graef, Clifford, Canada, was for a concentrated apple-juice.

The mode of practicing my invention is as follows: In my process I take ordinary fresh cider made from either sweet or sour apples, and to each gallon of such cider I add three-quarters of an ounce of bicarbonate of soda (NaHCO₃) and mix well.
I let it stand for ten minutes and remove the scum, which arises to the surface of the liquid. I next introduce such liquid into what is termed a 'jelly-evaporator,' operated by live steam, and boil until the liquid reaches the temperature of 220° Fahrenheit. I then run it off into a cooking-vat and leave until cool, when I place it in a copper kettle and heat to a boil over a fire. When the scum again rises to the surface, I skim until clean. This portion is now ready for use and is set aside until the rest of the process is finished. I next take the ground apples from which the cider has already been expressed and put them into a vat and cover with water. It is necessary that such water be pure, and it is boiled and cooled again to a tepid temperature before being added to the apple-gounds. After having covered the apples with tepid water and such water has been absorbed by the grounds the mass is put into the press and a fresh quantity of a weaker apple-juice is expressed. This is now treated similarly to the cider hereinbefore referred to, with the exception that I utilize a smaller quantity of the neutralizer, about one-half ounce to the gallon of fluid being sufficient. I repeat this latter part of the process a second time upon the ground apples left, so that in all there are preferably three expressings from the one lot of apples. Both of these latter portions are then mixed with the first portion hereinbefore referred to.

In practice I find that where there are three bushels of ordinary apples to the barrel I can make about four gallons of apple-syrup of a richer, better, purer, and more wholesome quality than by using only the cider first expressed and treated as described. The quantity of syrup produced is considerably increased to the old method and is treated in a smaller quantity. Not only is the quantity greater, but the quality. It is also much cheaper, as the apple-gounds hitherto useless are made useful by macerating and expressing again. Of course I do not limit myself to the exact quantity of bicarbonate of soda to be used, as it depends upon the kind of cider and must vary to some extent; but the quantity necessary is readily apportioned with but little experience.

A patent for a high-grade apple-juice was issued under No. 1,659,086, February 14, 1928, to E. R. Darling, Decatur, Illinois.

In the ordinary process of the manufacture of cider the apples are first crushed and subjected to pressure whereby the juice is obtained. A close study of the structure of the apple discloses the presence of a multitude of starch cells, which, during the process of expressing the juice act to prevent to a great degree the breaking down of the cell structure and therefore cause the retention of certain constituents including fruit sugars which if permitted to enter the juice would add materially to the flavor, the aroma and food value thereof.

Careful experiments have shown that by a process carried out in accordance with the invention herein disclosed, it is possible to break down the starch cells thus freeing the constituents otherwise retained thereby which may then pass into the juice and also the starch may be converted into fruit sugars.

It has long been known that enzymes have a great value in the preparation of food stuffs for human consumption and certain of these have the properties of converting starches into simple sugars which are easily assimilated. The present invention has applied these principles to a new use and as a result of the process a cider of unusual value is obtained.

The apples are first ground by any ordinary method and the pomace is placed in a tank which contains an agitator and means for heating. The enzyme which is preferred for the purpose of this invention is diastase and may be prepared by a method well known in the arts which consists in making a water extract of pure barley malt. This is best done by extracting one pound of the barley malt with one quart of water.

It is not possible to state the exact amount of enzyme which must be added to the pomace in order to convert the total starch into sugar but this must be controlled chemically and is determined as follows:

For each one hundred pounds of ground apples or pomace which is agitated in the tank and heated to approximately 135° F. there is added one quart of the water solution of the barley malt extract. At the end of fifteen minutes a small amount of the pomace is taken and tested for starch by means of iodine solution. If no color results, it is shown that all of the starch cells have been broken down and converted into sugar.

If a blue color results, it is apparent that more enzyme is necessary, and a further addition of the barley malt will be made, the amount thereof depending upon the brightness of the color resulting from the first test. At the end of another interval, a second test will be made and if necessary a further amount of enzyme added.
When the tests show that the pulp or pomace is free from starch, it is run into press plates and the juice expressed by means of pressure. It is found preferable to treat the juice with silicious matter such as diatomaceous earth and to use the plate type of filter press, although this is not imperative. It is also desirable to filter, bottle and Pasteurize the juice so that it may keep indefinitely in unchanged form for beverage purposes although the resulting juice may be used in any way in which cider produced by other methods is employed.

It is obvious that minor changes in the manner of carrying out the process may be made since other forms of enzymes may be used instead of diastase and such other forms of enzymes may have their best effect at a temperature differing somewhat from that set forth above. While it is found preferable to control the action by chemical tests, nevertheless the invention has marked value even if there is not added a sufficient amount of enzyme to break down all of the starch cells. The method as described is believed to set forth the preferred form of the invention but the invention is to be regarded as limited only by the scope of the appended claims.

Apple Sirup

Patent No. 1,141,458, issued to H. C. Gore, Washington, D. C., June 1, 1915, is for a “Process for making syrup from cider and other fruit juices” (Dedicated to the public).

My invention relates to a process for preparing syrup from cider and other fruit juices, such as juices from strawberries, oranges, grapes, pears and the like.

In practicing my invention I first place cider or the fruit juice in a vat or other suitable receptacle. I then add milk of lime to the cider or other fruit juice in such quantities that the free acid present in the juice is nearly, but not quite, neutralized and simultaneously stir the mixture with the addition of the lime. I so carry out the process that about nine-tenths of the free acids of the cider or other fruit juice are neutralized for two reasons: First, because it is desirable that a slight amount of free acid should remain in the finished product. Second, because it is difficult to obtain milk of lime free from coarse particles of lime, and if the juice is completely neutralized by milk of lime, these particles will gradually pass into solution rendering the juice alkaline. If the juice thus becomes alkaline, its quality is badly injured.

The next step consists in heating the juice almost or nearly to its boiling point, approximately 212° F. The reason for this step is that coagulation of certain suspended and dissolved substances occurs in such a way that subsequent filtration can be thereby accomplished. If the juice is not heated, it would be difficult to free it from certain dissolved and suspended matters occurring therein. The juice is then passed through a filter press to remove the suspended substances. While I prefer a filter press, any other device for accomplishing the separation of the coagulated substances from the juice may be employed. By adding a small amount, less than 1 per cent of infusorial earth to the juice, subsequent to its treatment with milk of lime and its subjection to heating, but before filtering, causes the filtration to proceed with much greater ease. I find that filtration may be carried on without using this material if so desired. I prefer, however, to use it as the infusorial earth greatly facilitates filtration. After the removal of the suspended matter in the manner described, I subject the solution to concentration. Any suitable evaporator may be employed, such as a steam jacketed kettle, a vat provided with steam coils, or a continuous evaporator. Upon thus concentrating, a syrup possessing an attractive color and flavor is formed together with calcium malate, which separates in the syrup while concentrating in the form of crystals and which further separates upon cooling of the syrup. The boiling point of the syrup at the time when it is filtered or finally concentrated is about 223° F.

The last and final step in my process consists in passing the syrup and crystals through a filter press to separate them. The syrup can then be treated by known means. I prefer to heat it nearly to the boiling point and pour, while hot, into containers in which it may be sealed. When so prepared it will keep indefinitely.

The crystals can be washed with water to free them from the adhering syrup, and if desired, can be further purified and worked up in various well-known ways.

I do not confine myself exclusively to the use of milk of lime for neutralizing the free acid in the cider. I find that calcium carbonate may also be employed as a neutral-
izing agent, however, I prefer milk of lime because I find by practice that the free acid in the juice can be neutralized more completely than by calcium carbonate.

I do not confine my process to the manufacture of syrup exclusively from cider, but this process may be employed in the manufacture of syrups from juices of other fruits such as strawberries, oranges, grapes, pears, and the like. In making syrup from fruit juices other than cider, I follow the same process as I employed in the manufacture from cider. In case these fruit juices contain citric or tartaric acids, I find that their calcium salts separate upon liming and heating to boiling, and are nearly all removed from the fruit juice at this stage of the operation. Malic acid, if present in sufficient quantities, will appear in the form of its calcium salt in the finished syrup.

Apple-Honeys

Patent No. 154,952, issued September 15, 1874, to Lewis Hurd, Kewanee, Illinois, is for “Improvement in edible compounds or apple-honeys”. The essential part is as follows:

This invention relates to a composition of matter intended more especially for table use, the preparation of which is as follows:

Take apple-cider, fresh from the press, and filter in any ordinary manner—preferably, however, through white flannel or dried honeycomb. After filtering, place it over a fire and raise the temperature to about 100° Fahrenheit; to every twelve pounds of the cider then add from eight to ten pounds of best quality of white sugar, and one-half of a lemon in slices; keep the temperature at about the above degree for the space of one hour, or until the ingredients are brought to the consistency of ordinary strained honey, and skim as required while it is simmering. Flavoring may now be added, if desired, but the flavor of the fruit used itself will generally be preferred. After it has been removed from the fire and cooled, it may be again strained through any ordinary fine strainer, or fine white cloth of any kind, to render it very clear, and free from sediment.

Other fruit than apples may be used, and will impart, of course, their particular flavor. The amount or proportion of sugar may also be varied as above, to regulate or control the tartness.

This composition will keep in the warmest weather without any difficulty or danger of deterioration, and in the coldest weather without danger of freezing, and will furnish an excellent and healthy article for table use, vehicle for the administration of medicines, etc.

It is unnecessary to add that such a product would be considered misbranded under the present food laws and the matter is presented to show what has been prepared.

Apple Jelly

Apple jelly from the by-products has also been patented under No. 1,045,849, December 3, 1912, issued to F. L. Jeffries, Granite City, Illinois.

My invention relates to certain improvements in the manufacture of jelly from fruit, such as apples, and particularly from apple trimmings, that is, the skins and cores of apples.

The improvement consists, first, in the removal from the fruit, by an operation hereinafter particularly described, of certain solubles which are valueless and, in fact, a detriment so far as the jelly is concerned, but which, when separated out, have a value of their own in other industries.

The object of the invention may therefore be said to be, first, the improvement in the grade or quality of the jelly, and, second, the saving as the by-product of certain substances which heretofore have been wasted.

In making apple jelly from the trimmings and cores of apples it has been found of advantage to cook the fruit in a closed vessel under steam pressure greater than
Atmospheric. The pressure usually is from ten to twenty pounds. The cooked fruit is afterward pressed in an ordinary cider or filter press. I have discovered, however, that better results can be obtained if the fruit before being subjected to the cooking step is steeped at a relatively low temperature and the resultant liquor drawn off. I have obtained excellent results in this preliminary steeping at a temperature in the neighborhood of one hundred and sixty degrees Fahrenheit, this, according to my present judgment, being the preferred temperature, but I do not necessarily limit myself to this temperature as lower or higher temperatures may be used provided they do not reach or closely approach the boiling point. The steeping releases or dissolves out from the fruit certain solubles which are of no value so far as the jelly is concerned. In fact, the quality of the jelly is improved when these solubles are removed. In addition, the liquor which results from the preliminary steeping has cider properties making it valuable for the manufacture of vinegar or boiled cider. After drawing off this liquor the residue of the fruit is cooked in the ordinary way at a temperature of two hundred twelve degrees Fahrenheit or above. For example, it may be boiled in a closed vessel at a steam pressure of say, ten to twenty pounds. The jelly is then made from the cooked fruit in the usual manner. That is, the fruit is put through a cider or filter press and the resultant liquor, containing the soluble solids released at the high temperature, mixed with some sugar-like substance. I have used syrup or sugar made from corn.

I have found that a further improvement can be made in the process by steeping the fruit taken from the press in water. In fact the pressing step may be omitted entirely and the high temperature solubles washed out instead by this steeping operation.

By-products
The waste from canning apples amounts to from 20 to 40 per cent, consisting of skins, cores, and fruit unsuitable for the purpose. These may be ground and pressed for vinegar stock or they may be cut and evaporated as chops or held for vinegar stock, or they may be used as stock food. This material is also cooked and pressed as a source of juice for jelly, or pectin may be prepared from it after the vinegar stock has been pressed out of it.

APRICOT

Prunus armeniaca

The apricot grows wild in Armenia and on the foothills of the Caucasus mountains. It was carried from that region into Greece, Italy, northern Africa, and eastward into northern India. The introduction into Mediterranean sections seems to have taken place shortly before the Christian Era for it is known from that time and it is reasonably certain that it was not known 300 B.C. as it is not included in a record of that period. It is not an old fruit, comparatively speaking, for there are no terms in the Sanscrit, Early Egyptian, or Hebraic languages which refer to it.

The apricot is closely related to the peach and plum, being intermediate between the two. The tree presents a rather attractive appearance, grows to a height of 20 to 25 feet, has a globular head, with leaves almost round or flattened heart-shape, inclined to turn in at the margin, and bright green in color. The flowers which are light or light pink open before the leaves in the spring and, while the tree is hardy, this habit makes a fruit crop subject to frost damage.

The fruit resembles the peach, though smaller and with less pubescence, varying in size from 1¼ to 2¼ inches in diameter. The flesh varies from
a light to a deep yellow, with some varieties having a tendency for one
side or the base to remain greenish after the other has developed a mature
color. The flavor is distinctive and particularly fine when ripe, which
occurs in the summer in advance of the peach.

The spread of this fruit seems to have been rather slow. It was intro-
duced into England from Italy in 1524 during the reign of Henry VIII.
It was there that two of our popular varieties were developed, the Moor-
park and Royal, and the name Blenheim would indicate a third.

The apricot was brought here by early emigrants and while east of the
Mississippi, was grown in home orchards, but never became a success as a
market fruit. It was carried to the west coast by the Padres when they
established the missions in the 18th century but the better varieties were
not introduced until after the middle of the 19th century. The valleys of
central California and southward are better adapted for the production
of this fruit than any other part of this country. Large acreages were
planted at one time but the crop is barely holding its own, owing to losses
from frost. This section is the source of practically all the fresh apricots
upon the market as well as those dried and canned. The varieties most
used for canning are the Royal and Blenheim. The Moorpark has the
best flavor but like the Hemskirk, though good, is rather small and irregu-
lar in ripening.

While apricot canning is not a large item as compared with some fruits,
it is more extensive than is generally surmised, but is subject to more vari-
ation than is usual for crops not planted annually or at short intervals.
Its maximum yield was reached in 1919. The record is as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915</td>
<td>981,000</td>
<td>1922</td>
<td>3,606,000</td>
<td>1929</td>
<td>4,211,000</td>
</tr>
<tr>
<td>1916</td>
<td>1,328,000</td>
<td>1923</td>
<td>1,562,000</td>
<td>1930</td>
<td>1,954,000</td>
</tr>
<tr>
<td>1917</td>
<td>2,356,000</td>
<td>1924</td>
<td>2,050,000</td>
<td>1931</td>
<td>2,005,000</td>
</tr>
<tr>
<td>1918</td>
<td>2,233,000</td>
<td>1925</td>
<td>2,196,000</td>
<td>1932</td>
<td>1,804,000</td>
</tr>
<tr>
<td>1919</td>
<td>4,395,000</td>
<td>1926</td>
<td>3,390,000</td>
<td>1933</td>
<td>2,415,000</td>
</tr>
<tr>
<td>1920</td>
<td>2,312,000</td>
<td>1927</td>
<td>3,116,000</td>
<td>1934</td>
<td>1,774,000</td>
</tr>
<tr>
<td>1921</td>
<td>1,150,000</td>
<td>1928</td>
<td>2,097,000</td>
<td>1935</td>
<td>3,164,000</td>
</tr>
</tbody>
</table>

The earliest record of commercial canning of apricots in California is
in 1863 by Cutting and Company.

The apricot has been handicapped both by being classed as a drying
fruit and as second to the peach, whereas the ripe apricot has a higher acid
content and a more distinctive and delicious flavor than the peach. The
green, immature or box-ripened fruit, as commonly sold in markets or on
stands, has a peculiar mild astringency and bitterness which detracts from
its true character. Since the fruit softens quickly upon becoming ripe,
and this factor interferes with sharp cut halves or pieces, it is customary
to pick fruit for canning when so-called hard-ripe or before the proper
flavor has developed, thus sacrificing quality to appearance.

The harvesting needs to be done when the fruit is as far advanced as
possible and still retain its form in handling. As the changes progress more
rapidly than in the ripening of most fruits, it is necessary to go over the
trees about four times to get the best results. The fruits directly exposed
to the sun burn or scald easily as soon as they soften, so harvesting cannot
wait for the fruit in the interior or on the shady side. Stripping the tree
in two operations is more economical but is done at a sacrifice in quality.
and an increase in the percentage of seconds and water grades. The pick-
ing is done directly into buckets or baskets and transferred to lug boxes
which hold an average of 40 pounds.

The lugs are brought to the factory or freight station promptly so that
the canning may be done the same day or the next following.

An inspection is made to determine whether the fruit meets the purchase
specifications which are as follows: "All fruit covered by this contract
shall be of good color, shape, quality, and in good condition for canning,
at the state of maturity buyer may require, free from doubles, worms,
scab, frost rings, hail or rain damage, red streaks in flesh, windfalls, visible
split pits, parasites, fungi, bruises, spray residue, gum or other imper-
fections. No. 1 apricots shall not be smaller than 12 to the pound."

Factory Operations

The lugs of apricots are emptied directly upon the grader, which is
usually a set of vibrating screens with openings 48, 56, 64, and 68 thirty-
seconds of an inch in diameter. The peach grader with special screens
usually serves the purpose. The fruit is carried by belts directly to the
preparation tables where any smutty or other spots are trimmed, then the
fruit split and pitted. The splitting is done along the natural line of cleav-
age as it leaves the halves symmetrical and the pits come away more easily.
This work is by hand as no machine has been developed which will do it
equally well or better. Moreover the pitter makes a preliminary sorting
on the basis of quality, placing the prime pitted fruit in one receptacle,
the hard and irregular in another, and the soft in a third. Pieces with sun
cracks, scald, leaf marks, etc., are also separated from the prime stock.
Shallow pans are most often used for keeping the grades separate and are
removed to the filling table at short intervals to avoid unnecessary darken-
ing of the cut surface.

The washed unpeeled fruit is filled into cans by weight, covered with the
appropriate degree of sirup, and preferably given a long exhaust at 175° F.
for 10 minutes. Apricots that are rather dry frequently contain much air
or gas and unless this is eliminated by exhausting there is danger of per-
foration of the can at some later date.

There is a growing demand for whole fruit both peeled and unpeeled.
Only graded, well colored and ripened stock is used. The pits impart a
flavor that is distinctive and so desired.

The apricot rarely requires a heavy cook; from 6 to 12 minutes suffice
for the No. 2½ can. If the cooking be done in a standing bath, a little
more time is needed for soft fruit than for firm, due to the irregularities in
heat penetration. The soft fruit rises to the top and mats together causing
the heat currents to run around the mass in the liquid instead of between
the pieces. In an agitating cooker the time can be reduced to from 6 to 8
minutes. The apricot is not cooled to the same extent as other fruits as by
holding the heat the color is deepened, whereas quick cooling gives a weak
bleached effect.

Relatively few apricots are peeled as the peel is so thin and cooks so
tender that it is not noticed appreciably when eaten. Lye peeling is gaining
in favor, however, and can be done quickly and easily in a regular peach
peeler. Only about one-half the strength of lye used for peaches is necessary and it is preferable that it be sprayed on rather than that the fruit be submerged in the solution. This treatment gives the peeled fruit a translucent appearance so that this refinement will probably be adopted as standard practice. The other steps in the preparation are the same for both.

**Standard Grades for the Canned Fruit (California)**

Fancy: Fruit to be of very high color, ripe yet retaining its form and free from blemishes serious for the grade, halves uniform in size and very symmetrical. In syrup: 55% sugar when packed.

Choice: Fruit to be of high color, ripe yet retaining its form and free from blemishes serious for the grade, halves uniform in size and symmetrical. In syrup: 40% sugar when packed.

Standard: Fruit to be of reasonably good color and reasonably free from blemishes serious for the grade, halves reasonably uniform in size, color, and degree of ripeness, and reasonably symmetrical. In syrup: 25% sugar when packed.

Seconds: Trade designation “Seconds.” Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size, color, and degree of ripeness. In syrup: 10% sugar when packed.

Trade Designation “Water”: Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size, color, and degree of ripeness. Packed in water.


**Maximum number of pieces per can:**

<table>
<thead>
<tr>
<th></th>
<th>3&quot;</th>
<th>3½&quot;</th>
<th>8 oz.</th>
<th>8 oz.</th>
<th>No. 1 Picnic</th>
<th>No. 1 Flat</th>
<th>No. 1 Tall</th>
<th>No. 2</th>
<th>No. 2½</th>
<th>No. 3</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fancy</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>19</td>
<td>24</td>
<td>29</td>
<td>36</td>
<td>108</td>
<td>86</td>
</tr>
<tr>
<td>Choice</td>
<td>11</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>20</td>
<td>24</td>
<td>30</td>
<td>36</td>
<td>42</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Standard</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>23</td>
<td>26</td>
<td>31</td>
<td>42</td>
<td>50</td>
<td>151</td>
<td>295</td>
<td>29</td>
</tr>
</tbody>
</table>

**Maximum variation in the number of pieces per can:**

<table>
<thead>
<tr>
<th></th>
<th>3&quot;</th>
<th>3½&quot;</th>
<th>8 oz.</th>
<th>8 oz.</th>
<th>No. 1 Picnic</th>
<th>No. 1 Flat</th>
<th>No. 1 Tall</th>
<th>No. 2</th>
<th>No. 2½</th>
<th>No. 3</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fancy</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Choice</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>Standard</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>29</td>
<td>25</td>
</tr>
</tbody>
</table>

**Label Weights Recommended**

Fancy (Sp. Gr. 1.10): 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08): 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 1 Tall, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 10, 6 lbs. 12 ozs.

Standard (Sp. Gr. 1.06): No. 1 Tall, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 10, 6 lbs. 10 ozs.

Seconds: No. 2½, 1 lb. 12 ozs. Water—No. 2½, 1 lb. 12 ozs.; No. 10, 6 lbs. 7 ozs. Pie—No. 10, 6 lbs. 8 ozs.; No. 10 solid pack, 6 lbs. 10 ozs.
General Observations

The records over several years show that in central California the pack averages about as follows: Fancy, 15; Choice, 40; Standard, 25; Seconds, 10; and Pie, 10 per cent, though considerable variation may occur from one year to another.

In the canning of apricots it requires on an average 33.4 pounds of good fruit for a case of No. 2 1/2 cans; 61.5 pounds for a case of No. 10 cans when sirup is used; 65 pounds for water grades; 83.3 pounds for solid pack, and 50 pounds for No. 1 Picnics. If peeled, it takes 37 pounds for a case of No. 2 1/2 cans, 68 pounds for No. 10 of the sirup grades, and 65 pounds for the water grades. Sliced fruit requires the same amount as the peeled.

Figures from other sources differ slightly, due in part to the fruit used and also to the ratio of fruit to sirup. One ton yields 55 cases No. 2 1/2 cans; the waste from pits, etc., amounts to 20 per cent.

The number of persons required to pack 2,000 cases, 36.5 tons of fresh fruit, in No. 2 1/2 cans in 10 hours is 100 cutters, 35 canners, 6 trimmers, 8 forewomen and inspectors, and 30 men to operate the machines and handle the fruit through the factory.

Effect of Maturity on Quality

In Bulletin No. 196, United States Department of Agriculture, the following experiment is reported to illustrate the difference between green and ripe fruit.

"An experiment was made to compare under-ripe and ripe fruit, the stock being selected from the same source and picking. The fruit which was in prime condition for canning was separated into one lot, and that which was evidently green, but which would have been used in the factory, was separated into another lot. The treatment of the two lots was identical, a 10° sirup being used in canning. A second experiment was made to compare apricots ripened on the tree with those ripened in storage. Fruit was again selected from the same source and picking and the prime-ripe canned at once, the green being held in boxes and ripened in the laboratory. The preparation and treatment were the same as in the first experiment, but a 30° sirup was used. Both sets show very clearly a difference on the cut-out, in appearance and flavor, and this is confirmed by the chemical examination. The green fruit shows in the paler and greener color, greater solidity, sharper cut edges, and pronounced acid taste. The characteristic green taste persisted in the storage-ripened and was only slightly less marked than in the fresh green fruit. A difference is shown chemically in acidity and in the form in which the sugar is present. This work was duplicated in 1913 under slightly different conditions but with the same general result, showing clearly the superiority of tree-ripened over green or storage-ripened fruit."

The apricot needs a heavier sirup than does most fruits to develop the color, conserve the flavor, and to hold the shape and texture of the pieces. In a water pack, the fruit tends to soften, to mat together and for the edges to slough. The heavier sirups cause shrinkage, but at the same time induce sufficient toughening to retain the shape. It also serves as a cushion against breakage or disintegration from the shaking during transportation.
Soft ripe apricots are sometimes kettle cooked until nearly pulp and then some firm fruit added for appearance.

**Composition**

The composition of the apricot as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>6.6</td>
</tr>
<tr>
<td>Water</td>
<td>85.4</td>
</tr>
<tr>
<td>Protein (N x 6.25)</td>
<td>1.0</td>
</tr>
<tr>
<td>Fat</td>
<td>1.0</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>12.9</td>
</tr>
<tr>
<td>Fiber</td>
<td>0.6</td>
</tr>
<tr>
<td>Sugars</td>
<td>10.4</td>
</tr>
<tr>
<td>Acid as malic</td>
<td>1.19</td>
</tr>
</tbody>
</table>

**By-Product**

The apricot kernel yields one of the finest oils for culinary uses in pastries and confections and there is no superior for Mayonnaise. The pits are saved by most of the larger canning and drying concerns and are sold to be exported to Germany. The refined oil is returned to this country as almond oil.

**BERRIES**

The term berry is used in a broad sense to cover almost any small succulent fruit which is most often produced upon low growing plants, vines, or bushes belonging to different genera and species.

The genus Rubus to which the brambles belong is scattered over both the north and south temperate zones and is particularly abundant on this continent. There are numerous variations of sufficient magnitude to be designated as species and a host of others of a minor character to be considered as varieties. No other genus affords an equal number of edible fruits and in none other do the plants adapt themselves more readily to environmental conditions or respond more promptly to culture.

The fruits are called Brambles, Blackberry, Dewberry, Sandberry, Raspberry, Blackcap, Mayberry, Wineberry, Thimbleberry, and Loganberry. In addition, there are purely local names and varietal names, such as Cuthbert. The raspberry is the favorite and used almost exclusively abroad but the foreign species which have been introduced here have not proven equal to the native, even when given proper cultural care.

The group embraces plants which are woody with a vining habit ranging from those having nearly erect canes to those which are spreading and procumbent, the majority of which are thorny, short lived, and replaced by new canes from the root crown. The leaves are generally trilobed ranging from broad to narrow with edges toothed; flowers white or light, usually in clusters; fruit a many-seeded berry easily separated from its conical base. The color ranges from black through dark red, red, yellow, to nearly white, the black and red being preferred.
The early settlers found these in such abundance that at first they were not cultivated; later they were given a place in the garden, and during the past half century they have been grown commercially. The most important producing section is in the Northwest in Washington and Oregon where large quantities of berries are grown for shipping in cold storage, and also for canning. The culture in the East and in the Lake region has decreased on account of fungous diseases.

Blackberry

*Rubus sp.*

The cultivated blackberries are all derived from the native plants of this country. Different species are distributed over almost the entire continent and while the fruits vary more or less, they are nearly all good and were generally used by the natives. The plant grows in such abundance along the edge of woodlands, roadways, and abandoned fields that cultivation is not attempted in many places though it responds promptly to care in increase of the size of the berry, lessened proportion of seeds, and increase in yield.

The plant is thorny with an erect growing habit, producing canes which grow to a length of 6 to 10 feet but which are restricted by pruning when cultivated in gardens. The leaves are of moderate size, three-parted, with notched edges; blossoms, white; the berries most often elongated, in clusters, and generally black. The berry is cylindrical, made up of many seeds each with a surrounding capsule of pulp. The flavor is characteristic and rather sweet and has long been esteemed especially for jam. It early gained a reputation among the rural people as being beneficial in intestinal disorders, especially diarrhoea. It is not canned on a large scale although it is a fruit that holds its flavor well. The principal canning is done in the Southeastern section and in the Northwest.

**Composition**

The composition of the blackberry and blackberry juice, as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Blackberries</th>
<th>Blackberry Juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>85.3</td>
<td>92.3</td>
</tr>
<tr>
<td>Protein</td>
<td>1.2</td>
<td>.3</td>
</tr>
<tr>
<td>Fat</td>
<td>1.1</td>
<td>.0</td>
</tr>
<tr>
<td>Ash</td>
<td>.47</td>
<td>.39</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>11.9</td>
<td>7.0</td>
</tr>
<tr>
<td>Fiber</td>
<td>4.1</td>
<td>.0</td>
</tr>
<tr>
<td>Sugars</td>
<td>6.1</td>
<td>5.4</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>.91</td>
<td>.92</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>62.3</td>
<td>29.2</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>285.</td>
<td>130.</td>
</tr>
</tbody>
</table>

The berries are gathered in shallow boxes and packed in crates or chests to insure maximum protection from superimposed weight and from bruising. The berries should be fully colored but not allowed to become soft before picking, otherwise they collapse or break to pieces in cooking. In commercial growing, it is necessary to pick every day or every other day in order to obtain them at their best.
The berries need to be handled promptly, otherwise they soften, break down, and mold. In the factory, they are turned out upon a picking belt where any defective or unfit stock is taken out and the remainder passed directly into the washing machine to be subjected to the action of gentle sprays of water. The pack amounts to about 640,000 cases, two-thirds of which are in No. 10 cans and 25 per cent in No. 2 cans.

The filling of the cans is a hand operation and is probably done more conveniently from a belt extending from the washer than in any other way. The berries are discharged on a white rubber belt in a single layer from which they can be picked up with a flat scoop and filled into the cans with minimum handling. Large berries need to be filled into the cans at the rate of 19 to 19.5 ounces and smaller ones at the rate of 20 to 21 ounces for the No. 2½ size can. This necessitates partial filling, slight tapping on the table, completing the fill, and again tapping the can on the bottom to cause the fruit to settle. The tapping is done carefully to avoid any mashing. The amount of water carried into the can with the fruit is no greater than with the older method of dipping the berries from a table bin containing water, but to reduce this factor to the minimum, the cans are run through a drainer before siruping or in small operations a wire screen held over the cans while on a tray and the lot inverted by hand. If the cans be simply filled level full without tapping, they present an appearance of slack filling on the cut-out.

A sirup is needed but it should not be too heavy in order to have the best results. A 50 degree sirup causes excessive shrinkage and toughening of the berries and owing to the low acidity is not needed. A 30 to 35 degree sirup gives a much better appearance, texture, and flavor. Packing in water is objectionable for the reason that it leaches out the natural sweetness and flavor of the fruit. The minimum should probably not be less than 15 degrees in order to conserve both appearance and flavor.

A moderately long exhaust, 10 to 12 minutes at 180° F., gives a better result than does a quick exhaust at 210°. The time for cooking No. 2½ cans is 10 minutes at boiling.

It requires on an average 36 pounds of good berries per case for No. 1 tall cans; 21.2 pounds for No. 2; 31 pounds for No. 2½; 60.3 pounds for No. 10, sirup grades; 63.3 pounds for No. 10, water grade; and 80 pounds for No. 10, solid pack.

**Effect of Varying Degrees of Sirup on Blackberries and the Cut-out Weight of Fruit and Sirup**

Weight of fruit used, 550 grams (19.5 ounces), for No. 2½ cans. (San Francisco):

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Brix Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>818</td>
<td>471</td>
<td>347</td>
<td>7.2</td>
</tr>
<tr>
<td>20</td>
<td>845</td>
<td>470</td>
<td>375</td>
<td>15.1</td>
</tr>
<tr>
<td>30</td>
<td>862</td>
<td>453</td>
<td>409</td>
<td>19.4</td>
</tr>
<tr>
<td>40</td>
<td>881</td>
<td>463</td>
<td>418</td>
<td>22.9</td>
</tr>
<tr>
<td>50</td>
<td>908</td>
<td>438</td>
<td>470</td>
<td>27.9</td>
</tr>
<tr>
<td>60</td>
<td>920</td>
<td>425</td>
<td>495</td>
<td>33.0</td>
</tr>
</tbody>
</table>

(Table continued on next page)
Weight of fruit, 400 grams (14 ounces), for No. 2 can (Washington):

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Brix Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>594</td>
<td>366</td>
<td>228</td>
<td>6.4</td>
</tr>
<tr>
<td>10</td>
<td>590</td>
<td>362</td>
<td>228</td>
<td>10.0</td>
</tr>
<tr>
<td>20</td>
<td>564</td>
<td>339</td>
<td>225</td>
<td>12.1</td>
</tr>
<tr>
<td>30</td>
<td>590</td>
<td>338</td>
<td>252</td>
<td>16.1</td>
</tr>
<tr>
<td>40</td>
<td>611</td>
<td>344</td>
<td>267</td>
<td>20.6</td>
</tr>
<tr>
<td>50</td>
<td>621</td>
<td>337</td>
<td>284</td>
<td>24.2</td>
</tr>
</tbody>
</table>

Weight of fruit, 400 grams to No. 2 cans (Chicago):

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Brix Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>573</td>
<td>365</td>
<td>208</td>
<td>5.7</td>
</tr>
<tr>
<td>10</td>
<td>598</td>
<td>352</td>
<td>246</td>
<td>10.8</td>
</tr>
<tr>
<td>20</td>
<td>610</td>
<td>306</td>
<td>304</td>
<td>16.9</td>
</tr>
<tr>
<td>30</td>
<td>614</td>
<td>287</td>
<td>327</td>
<td>19.1</td>
</tr>
<tr>
<td>40</td>
<td>613</td>
<td>267</td>
<td>346</td>
<td>22.8</td>
</tr>
<tr>
<td>50</td>
<td>645</td>
<td>236</td>
<td>409</td>
<td>29.7</td>
</tr>
</tbody>
</table>

Standards (Northwest Canners’ Association)

Fancy Grade. Description: Fruit to be of very fine quality, free from blemishes and uniform in size. Sirup: Per cent of sugar when packed, 50.

Choice Grade. Description: Fruit to be of fine quality, free from blemishes and uniform in size. Sirup: Per cent of sugar when packed, 35.

Standard Grade. Description: Fruit to be of good quality, reasonably free from blemishes, and reasonably uniform in size and degree of ripeness. Sirup: Per cent of sugar when packed, 20.

Seconds Grade. Description: Fruit to be tolerably free from blemishes and fairly uniform in size. Sirup: Per cent of sugar when packed, 10.

Water or Pie Grade. Description: Wholesome fruit. Sirup: Per cent of sugar when packed, 0.

Label Weights

Fancy (Sp. Gr. 1.08): 8Z Short, 7¾ ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Choice (Sp. Gr. 1.06): 8Z Short, 7¾ ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Standard (Sp. Gr. 1.05): 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

Water (Sp. Gr. 1.03): Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 7 ozs.
Blueberries

_Vaccinium corymbosum, V. pennsylvanicum_

These two species of shrubs are native to this country, the former being known commonly as the marsh or swamp blueberry, huckleberry, or whortleberry, and the latter as the dry-land blueberry. They are found growing in swamps and low sandy lands, and one species on dry land from well up in Canada, south to Virginia, and westward to the Great Lakes. The principal production of the fruit is in Maine, Canada, and Michigan, and almost wholly from the wild bushes, for little attention has been given to cultivation. The marsh type of bush grows from 4 to 10 feet in height while the other on dry soil grows from 1½ to 4 feet in height. Both require an acid soil, and preferably one mixed with peat.

The fruit is a small berry produced in clusters and ranges from one-fourth inch to nearly a half inch in diameter. They are dark blue with a lighter bloom on the surface, and on the inside, the pulp is bluish red, and the filtered juice a stronger red. The berries are globular with a prominent remnant of the blossom persisting. They have a very pleasing sweet flavor that is practically the same in the two species. They were used by the Indians before the arrival of the white man, and the latter and his successors have been fond of them, though it seems strange that they are not more extensively cultivated. Nearly the entire crop is absorbed by the fresh market and for home canning. Credit for pioneering in the commercial canning of this fruit is due to A. L. Stewart, Cherryfield, Maine, who began packing in 1868, and the work has been continued each season at the same place and by the same family. According to the _American Grocer_, the Portland Packing Company practically controlled the industry in 1875, producing from 16,000 to 20,000 cans daily. The industry at present has a value of about $1,000,000 annually, about 80 per cent of the packing being done in Maine. Harvesting the blueberry begins in the South in Maryland about July 20, in the North about the first of August, continuing for about five weeks. The berries are picked by hand, or when they are abundant and well ripened, the work being aided with a claw or a small coarse comb. They are fairly firm, and if handled with reasonable care, do not spoil as readily as most fruits, though in order to conserve them they need to be handled in shallow boxes or crates.

In canning, the berries are run through a fanning mill to blow out all loose leaves, sticks, stems, etc., as this materially reduces the hand labor in picking them over. The berries are then washed, first by being placed in tanks of water so that light fruit floats and may be skimmed off, and then by sprays, after which they are delivered upon an inspection belt to remove any defective stock.

If a long belt be used, the cans may be filled directly from the belt instead of being delivered to filling tables. It is as easy to take the berries from the belt by means of a scoop as it is from pans or table bins. As a final step, water or sirup is added to fill the interstices.

The blueberry is easy to sterilize. A 10-minute exhaust is given and a process of from 6 to 10 minutes for No. 2, and 18 minutes for No. 10 cans. A common method is to heat the berries with the proper quantity of water in a corn cooker, and to fill the cans continuously by that machine, or they
may be cooked in a kettle and filled hot, sealed, without subsequent cooking. As a matter of safety, it is better to give a short cook.

The No. 10 cans are almost exclusively for pie bakers, and nearly all are water packed. The No. 2 cans are for family use, and more than 50 per cent, as well as all those packed in glass, are put up in sirup. The sirup protects the flavor, color, and to a certain extent the shape, and should be about 30 degrees. When packed with 30 or 40 degree sirup, the fruit makes a most acceptable dessert with a rich, distinctive flavor.

The blueberry does not collapse upon heating as the outer wall is sufficiently resistant to hold its shape, and at the same time so tender that it is not objectionable when being eaten. Cans which are filled to within three-eighths inch of the top, cut-out to within one inch of the top. Plain cans are undesirable as the color is bleached from the fruit and the flavor injured. Glass is the preferable container for quality.

### Effect of Varying Degrees of Sirup on Cut-out

#### No. 2 Can, 330 grams (11.6 ounces) fruit (Washington):

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Brix Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>557</td>
<td>327</td>
<td>230</td>
<td>8.7</td>
</tr>
<tr>
<td>10</td>
<td>550</td>
<td>323</td>
<td>227</td>
<td>12.5</td>
</tr>
<tr>
<td>20</td>
<td>566</td>
<td>330</td>
<td>236</td>
<td>15.9</td>
</tr>
<tr>
<td>30</td>
<td>590</td>
<td>328</td>
<td>262</td>
<td>19.2</td>
</tr>
<tr>
<td>40</td>
<td>610</td>
<td>328</td>
<td>282</td>
<td>24.0</td>
</tr>
</tbody>
</table>

#### No. 2 Can, 330 grams (11.6 ounces) fruit (Chicago):

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Brix Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>566</td>
<td>311</td>
<td>255</td>
<td>9.3</td>
</tr>
<tr>
<td>10</td>
<td>588</td>
<td>343</td>
<td>245</td>
<td>13.0</td>
</tr>
<tr>
<td>20</td>
<td>603</td>
<td>331</td>
<td>272</td>
<td>17.3</td>
</tr>
<tr>
<td>30</td>
<td>612</td>
<td>302</td>
<td>310</td>
<td>20.6</td>
</tr>
<tr>
<td>40</td>
<td>610</td>
<td>310</td>
<td>300</td>
<td>24.1</td>
</tr>
<tr>
<td>50</td>
<td>628</td>
<td>286</td>
<td>342</td>
<td>29.7</td>
</tr>
</tbody>
</table>

#### Label Weights

40 Sirup (Sp. Gr. 1.05) : 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

Water (Sp. Gr. 1.02) : Picnic—No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 1 lb. ; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 6 ozs.

#### Composition

The composition of the blueberry as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Ash</td>
</tr>
<tr>
<td>Carbohydrate</td>
</tr>
<tr>
<td>Fiber</td>
</tr>
<tr>
<td>Sugar</td>
</tr>
<tr>
<td>Acid as citric</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
</tr>
<tr>
<td>Calories per pound</td>
</tr>
</tbody>
</table>
The most serious difficulty in the packing of blueberries is the separation of sound fruit from that infested with maggots, particularly berries picked late in the season. The early fruit shows slight attack, but the late fruit, and especially in some seasons, is likely to have a considerable proportion infested. Two patents have been granted for devices to make the separation. No. 1,544,894, issued July 7, 1925, to E. F. Farnsworth, Portland, Maine, is for a device based upon the principle of a difference in specific gravity in sound and infected fruit. The infected fruit will float in water and can be removed by skimming while the sound fruit will sink. Patent No. 1,615,700, issued January 25, 1927, to B. J. Howard and C. H. Stephenson, Washington, D. C., is based upon the fact that infected fruit is less solid than sound fruit, and that by rubbing them together in a thin layer the infected will be reduced to pulp and can be passed through a screen. In this case the berries are fed into a cylinder having a screen for a shell and by gentle rubbing, the broken berries pass through and the good ones discharge over the end. The screen is mounted in a tank of water. The apparatus is small, but is said to have a capacity of about 400 bushels per day.

Dewberry
Rubus sp.

The dewberry belongs to the same genus as the blackberry, but in this case the bush has a trailing habit. Recognition of it as a different species was not made until 1863. The fruit is generally a little softer and sweeter than the blackberry. Considerable quantities are grown for the fresh fruit market near the eastern seaboard and any surplus canned in the same way as the blackberry.

Cranberries
Oxycoccus macrocarpus

The cranberry is a native vine found in the swamps and lowlands of the northern states and in southern Canada. While rather widely distributed, it occurs only sparingly except in a few places in New England, New Jersey, and Wisconsin. A different species, the low-bush cranberry or wolfberry, occurs in Nova Scotia, and another in the Northwest in Oregon and Washington. Closely related species occur in northern Europe—Russia, Poland, Finland, and Sweden—the berries being smaller but having the same characteristics.

The plant is a low-growing evergreen vine with simple alternate leaves, single flowers, and a bright dark red fruit generally slightly elongated but otherwise resembling a cherry. The arrangement of the flowering parts, that is, the extension of the stamens and pistil and the turning back of the corolla, give an imaginary resemblance to a crane’s head, and from that was derived the original name cranberry, later shortened to cranberry. The growth is developed above moss in bogs or swamps, the vines trailing for several feet with short vertical stems of six to eight inches at close
The fruit is fleshy and firm, maturing rather late in the fall, and is very acid so that it cannot be eaten raw though excellent when cooked and sugar added. It was used by the Indians prior to the discovery of this country. They ate the berries when fully ripe, as they are less acid in that stage, kept them in vessels covered with water, and also dried them. In the hands of the immigrants, who were familiar with cranberries in tarts in the old country, they were used as a sauce, which thus became the first distinctive American sauce, used on meats in the fall and winter, but within recent years made available at all times.

**Cultivation**

The cultivation of the cranberry is said to have been attempted at North Dennis, Massachusetts, about 1820, but owing to the peculiar nature of the plant and the ease with which the wild berries could be collected very little progress was made. It took thirty years or more to learn the essentials for preparing a bed and how to handle it to produce a crop. Even in recent times the cultivation has been slow for the reason that only acid land of a peaty or mucky character, which can be drained during the summer season...
APPERTIZING

and irrigated during drought or flooded when needed at other times, is suitable. The cost of preparation is high for clearing, leveling, covering with a layer of sand, ditching, building dykes, and providing a reserve water storage, etc. Some estimates place this cost as high as $1,500 per acre. Certain strains of the berries have been selected and improved by cultivation and it is from these that cuttings are used to start new beds. The plants are set out in rows about 15 or 16 inches apart and a like distance in the row. The root must go through the layer of sand into the peat. It requires from three to four years to get the first crop, after which the beds remain in bearing condition for a long time. The total area of bogs under cultivation in the entire country probably does not exceed 55,000 acres, with a yield of about 500,000 barrels annually. Less than one-half of the acreage but about 75 per cent of the production is in Massachusetts.

The harvesting is done by means of a rather coarse comb which strips the berries from the vines. The berries are separated by running the combings through a fanning-mill to blow out the leaves and other extraneous matter, the fruit then separated into hard-ripe and fully matured by dropping on bouncing boards, the hard-ripe berries bouncing a greater distance and falling into appropriate compartments, while those which are fully mature roll into another. The great bulk of the crop is packed in barrels and crates to be marketed fresh or from cold storage during the fall and winter until about March. The more mature berries are canned in the form of sauce.

Natural Resistance to Spoilage

Cranberries differ from other berries in that they have a high benzoic acid content which imparts a marked resistance to rot, and thus keep well with the minimum of protection. Even the Indians were familiar with their unusual keeping qualities and kept the berries covered with water. One of the early patents upon food preservation in this country is based upon
this principal and so unlike any other that it is quoted in full. Patent No. 37,058, December 2, 1862, issued to Abiel Sampson, Providence, Rhode Island, is as follows:

Heretofore cranberries, as an article of domestic consumption, have been obtainable only through the fall, winter, and early spring months, owing to the fact that this fruit softens and decays rapidly at the approach of the warm season or by exportation to a warmer climate. This softening and decaying may be arrested and delayed for a time by keeping the fruit in water and changing the water frequently, which is the method generally employed by farmers and others having a small quantity on hand for their own consumption.

My invention consists in putting up cranberries in hermetically-sealed packages of convenient size and form for family use or exportation, the fruit being preserved in its natural condition in such packages by being submerged in water, by means of which this fruit may be preserved in a convenient and salable form throughout the year for more than one season and in a warm climate. This method of putting up and preserving cranberries has numerous advantages, for, whereas this fruit especially is injured in quality and flavor by the ordinary method of preserving fruit in sealed packages by first cooking or partially cooking the same and expelling the air therefrom by heating the fruit in the jar, can, or package, whatever it may be, and sealing the same while it is hot, by expelling the air from the fruit by submerging it in water in the can, jar, etc., and afterwards sealing the same, this fruit is preserved in its natural condition for a great length of time without impairing either the quality or flavor of the same in the least degree. Besides this, cranberries may be preserved in this way much cheaper than by the ordinary method, a package of this kind costing but little more than the fruit of itself, and this fruit is afforded in the most desirable form and condition for either home consumption or exportation at a season of the year when it has not heretofore been obtainable.

In putting up cranberries by my improved method either glass or metallic jars or cans may be used, or wooden kegs with air-tight seams. The berries should be gathered in cool weather, and submerged in water soon after gathering. After being placed in the jars or cans the latter should be at once sealed and put away in a dry, cool situation until wanted for cooking or transportation. Cranberries put up in this form or manner afford a delicious and useful sauce on shipboard on long voyages and in localities visited by epidemic fevers, as it is possible to distribute this fruit in this form in localities and climates where it has been hitherto unknown.

Having thus described my invention, I wish it understood that I do not claim, broadly, submerging in water as a means for preserving cranberries, as this is well known; also, that I do not restrict myself to any particular form or size of package, intending to make use of any and every kind or style of package which I may use lawfully, suitable for preserving and transporting the submerged cranberries with convenience and success.

What I claim as my invention and desire to secure by Letters Patent is—

"The merchantable package of cranberries preserved in their natural condition by being submerged in water, as a new manufacture or article of trade."

In a series of tests upon spoilage, the cranberry was one of the fruits used. One pound of berries was placed in a quart bottle, covered with water and sealed, a pressure gauge being inserted in the stopper. One lot was held at low room temperature 68° F. and another lot at 100° F. for six months. Duplicate sets were prepared with the addition of two ounces of sugar in each bottle and kept under the same conditions. At the end of four weeks, the sets with and without sugar, kept at room temperature, had developed one and one-half pounds of pressure with no increase after that time. The sets in the warm bath did not develop pressure at any time. A macroscopic examination showed little breaking down of tissues and the microscopic examination showed few organisms.
Composition

According to Circular 50, United States Department of Agriculture, the average composition of cranberries is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>87.4</td>
</tr>
<tr>
<td>Protein</td>
<td>.4</td>
</tr>
<tr>
<td>Fat</td>
<td>.7</td>
</tr>
<tr>
<td>Ash</td>
<td>.2</td>
</tr>
<tr>
<td>Carbohydrates (total)</td>
<td>11.3</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.4</td>
</tr>
<tr>
<td>Sugar</td>
<td>4.2</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>2.36</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>53.2</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>240.0</td>
</tr>
</tbody>
</table>

E. K. Nelson has shown that the acidity in the cranberry differs from that found in most fruits in that it is made up of three acids, nearly 80 per cent being citric, 20 per cent malic, and 0.069 per cent benzoic.

Prof. F. W. Morse of the Massachusetts Agricultural Experiment Station has found the ash exceptionally high in iodine.

In 116 lots of berries representing 61 varieties, the acid varied from 1.87 to 2.71 per cent, and the sugar from 2.45 to 5.66 per cent. Thirty-two samples showed less than 3.5 per cent sugar; 45 samples between 3.5 and 4.5 per cent; and 35 samples more than 4.5 per cent. The highest percentage of sugar always occurred in ripe berries.

Canning

The canning of cranberries differs from most other fruits in that they are prepared in the form of a sauce rather than as whole fruit, and this practice dates back to the very beginning of the industry in this country. It has another distinction in that it began as a commercial operation instead of in the home. The first record of its canning is contained in a letter by a pioneer American canner, William Underwood, of Boston, dated January 10, 1828, addressed to Captain Stanwood of the Ship Augusta:

"Dear Sir:

"Enclosed you have invoice of pickles, sauces, mustards, and preserves of first quality. I have invoiced them considerably less than first quality of goods can be purchased in London, which will be some guide to you. Should you not be able to sell them for more than cost and charges in South America, it will, I think, be best to take them to Manila. The cranberries in the bottles are preserved without sugar. I name this because should any person purchase them for sweetmeats they would be disappointed. They are to be used precisely as if purchased fresh from the market, and will keep any length of time before the cork is drawn. Any English people will understand them, and should you fall in with any Men-of-War they will be very agreeable for ship stores, for cabin use, and for any American families who wish for cranberry sauce. The cranberry jam is a sweetmeat and usually brings a high price; I have frequently sold it in India for $1.50 per jar. You will use your own judgment and invest the proceeds as you think best, but I should prefer to have some Manila hemp or sugar.

"Your honorable servant,

"William Underwood."
Cranberry jam was also one of the early products put on the West Coast. An inventory of Cutting and Company of San Francisco shows they were packed in 1865 from berries obtained in Vancouver.

The canning of cranberries in the form of sauce is advantageous in two ways, first in conserving the ripe berries which show softening and, therefore, would not carry well, and in making available a certain amount of the product throughout the year. The real packing upon a commercial scale dates only since 1922. Previous to that time, the work was done upon a small scale by a number of packers, but in that season the United Cape Cod Cranberry Company packed 5,000 cases, and this has increased each subsequent year until it reached 275,000 cases in 1928. The pack for the entire country at that time was 425,000 cases.

The commercial preparation of cranberry sauce follows closely that used in the kitchen but naturally on a larger scale. The berries are cleaned of all foreign debris, washed, and a quantity weighed to make a standard batch according to the size of the kettle used. An equal weight of water is added. The berries being very meaty, very acid, and rich in pectin need the addition of more water than do most fruits, and it also follows that more sugar will be required in a subsequent operation. The fruit is boiled until the skins crack and the pulp is softened, which for well ripened berries will be from 3 to 6 minutes. They are then run through a pulping machine, the skins and seeds removed, and the pulp finely divided and made smooth. The loss in tailings is small, only about 3 per cent. The pulp is returned to a kettle to have the sugar added according to a batch formula, or tests can be made for pectin and acidity and the exact amount of sugar and water calculated to give the maximum yield of sauce. In the batch method, about 4 pounds of sugar are added for each 3 pounds of pulp if produced from equal weights of fruit and water in the preliminary cooking. The batch is
cooked from 8 to 10 minutes or to 218° F. If the temperature be above that point, some water may be added, and if below, the evaporation is continued until it reaches that point.

The kettles used may be glass-lined or of nickel or aluminum, but not of tin or copper as these produce a purplish discoloration. The simplest procedure is to run the finished product directly into the filling machine, though more commonly the batch is run into a receiving tank. The objection to holding in the cooking kettle is that some material will stick on the metal. Either glass jars or enamel-lined cans may be used for the sauce, but the former is preferred. Cooking is not necessary if the operation of filling be done while the product is hot, but if allowed to drop below 165° it is safer to place the jars or cans in a bath at 185° for 6 minutes. The addition of such a large amount of sugar makes spoilage possible where the product alone would keep.

Cranberry sauce packed in plain tin is likely to show some discoloration. An experimental lot of cranberries packed for comparison with other fruits, using pint jars and varying the degree of sirup, gave the following results:

### Effect of Varying Degrees of Sirup Upon the Cut-out

<table>
<thead>
<tr>
<th>Pint jars:</th>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>407</td>
<td>223</td>
<td>184</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>414</td>
<td>227</td>
<td>187</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>398</td>
<td>225</td>
<td>173</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>421</td>
<td>228</td>
<td>193</td>
<td>24.1</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>403</td>
<td>231</td>
<td>162</td>
<td>34.5</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>423</td>
<td>261</td>
<td>162</td>
<td>42.7</td>
<td></td>
</tr>
</tbody>
</table>

The cranberry grown in the Northwest is *Oxycoccus ovalifolium*, a somewhat smaller species than that grown in the East, but the fruit is very similar in its general characteristics. Some of these are canned in the same manner as other fruits and local standards for the packing have been adopted.

**Standards** (Northwest Canners' Association)

Fancy Grade. Description: Fruit to be of very fine quality, free from blemishes, and uniform in size. Sirup: Per cent of sugar when packed, 60.

Choice Grade. Description: Fruit to be of fine quality, free from blemishes, and uniform in size. Sirup: Per cent of sugar when packed, 40.

Standard Grade. Description: Fruit to be of good quality, reasonably uniform in size and degree of ripeness. Sirup: Per cent of sugar when packed, 20.

Second Grade. Description: Fruit to be tolerably free from blemishes, and fairly uniform in size. Sirup: Per cent of sugar when packed, 10.

Water or Pie Grades. Description: Wholesome fruit. Sirup: Per cent of sugar when packed, 0.

**Label Weights for Cranberry Sauce**

(Sp. Gr. 1.17): 8Z Short, 8½ ozs.; 8Z Tall, 9½ ozs.; Picnic—No. 1 East, 12 ozs.; No. 300, 1 lb.; No. 1 Tall, 1 lb. 2 ozs.; No. 303, 1 lb. 2 ozs.; No. 2, 1 lb. 6 ozs.; No. 2½, 2 lbs.; No. 3, 2 lbs. 5 ozs.; No. 5, 3 lbs. 15 ozs.
The currant is indigenous to northern Europe, Siberia, and America, thus showing a wide distribution in the cooler part of the north temperate zone. The common red currant is a domesticated form of the European species and has never departed far from its primitive condition. Its cultivation seems to have begun sometime during the Middle Ages, but it was still a rare plant in gardens at the beginning of the 17th century. The fruit is too acid to be eaten alone, but is used with added sugar, and in cookery to give piquancy to other foods. Its modern use is for jelly-making and for this purpose it has no superior; the flavor is fine, consistency perfect, transparent, and of bright, unexcelled color.

The bush is low growing, from 2 to 4 feet in height, many stemmed, has rather soft leaves, inconspicuous flowers, but brilliant small red fruit in clusters which ripen in August. The berries bring a high price. One of the drawbacks to currant raising is that the plant is subject to both insect attack and fungous diseases.

**Composition**

The composition of the currant and currant juice as given in Circular No. 50, U. S. Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Currant Fruit Per cent</th>
<th>Red Currant Juice Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>84.7</td>
<td>89.1</td>
</tr>
<tr>
<td>Protein</td>
<td>1.6</td>
<td>.3</td>
</tr>
<tr>
<td>Fat</td>
<td>.4</td>
<td>.0</td>
</tr>
<tr>
<td>Ash</td>
<td>.61</td>
<td>.54</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>12.7</td>
<td>10.1</td>
</tr>
<tr>
<td>Fiber</td>
<td>3.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Sugar</td>
<td>5.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>2.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Fuel value per 100 grams</td>
<td>60.8</td>
<td>41.6</td>
</tr>
<tr>
<td>Fuel value per pound</td>
<td>225.0</td>
<td>190.0</td>
</tr>
</tbody>
</table>

The currants are gathered when the fruit is fully colored but not soft, the clusters removed as a whole and placed in small boxes not more than 2½ inches in depth. They need to be handled promptly as they mold and spoil easily in spite of their high acidity.

Since the few currants that are canned are used almost exclusively for jelly stock and for juice for flavoring, two procedures are open: To stem the berries and pack whole, or to steam them and press the juice. The work of stemming is too laborious for any except those destined for decoration or for home use, so that steaming and pressing is the mode usually practiced. The stems should not be left on under any circumstances as they impart a bitter astringent taste, and moreover sterilization is more difficult. Washing is done after stemming when the fruit is packed whole, or of the clusters if pressed. It is not wise to pack either the berries or the juice in metal cans as springers and hydrogen swells result in a short time, the color is bleached, and the flavor injured. Lacquer-lining aids in keeping, but does not prevent the trouble. Glass is the satisfactory container and storage should be away from the light.
Sterilization is easy, 5 minutes at boiling being sufficient for a No. 2 can, and 15 minutes for a No. 10 can. Doubtless a better product could be obtained by using a lower temperature for a longer time.

**Effect of Varying Degrees of Sirup on Currants in the Weight of Cut-out of Fruit and Sirup**

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>592</td>
<td>277</td>
<td>315</td>
<td>11.7</td>
</tr>
<tr>
<td>20</td>
<td>605</td>
<td>288</td>
<td>317</td>
<td>16.4</td>
</tr>
<tr>
<td>30</td>
<td>633</td>
<td>263</td>
<td>390</td>
<td>22.9</td>
</tr>
<tr>
<td>50</td>
<td>647</td>
<td>270</td>
<td>377</td>
<td>30.4</td>
</tr>
<tr>
<td>60</td>
<td>640</td>
<td>235</td>
<td>405</td>
<td>35.0</td>
</tr>
</tbody>
</table>

**Label Weight**

Water Pack (Sp. Gr. 1.06): No. 10, 6 lbs. 10 ozs.

**Gooseberries**

*Ribes grossularia*

The gooseberry is native to both northern Europe and America and probably grows farther north than any other domesticated fruit. At least one species is found near the Arctic circle. The common garden varieties are principally of European origin, though two or three promising varieties have originated in Canada.

This bush, like the currant, was not known to the ancients of southern Europe nor does it seem to have been known prior to the 16th century. It is not an important cultivated plant, only a small quantity of its fruit being used and this mainly immature and green for sauces and pies. The name gooseberry is of English origin because of the sauce accompanying goose, while in France it is known as mackerelberry from the sauce served with that fish.

The gooseberry is produced on a low-growing bush similar to that of the currant, but the stem is more prickly, the leaves more pubescent, and the berries instead of being in clusters are single or in pairs at short intervals along the stem. The berries are considerably larger than the currant and average about a half inch in diameter. It is a bright transparent green when immature and reddish when ripe. It is decidedly acid but with plenty of sugar makes an excellent pie, tart, or jam. The annual pack amounts to less than 50,000 cases.

The first operation at the factory is to pass the berries through a fanning mill to remove bits of leaves and other material caught in the picking. This is followed by the removal of the stems and remnants of brown blossom ends, which when carried out as a hand operation was known as topping and tailing. The work is now all done with a device known as the Urschel gooseberry snipper. It consists of a horizontal metal disk containing many narrow slits. Below the disk but in immediate contact with it are a number of knife blades which clip off the stems or blossom ends that project
through the slits. The berries are fed from a hopper upon the center of the disk and arms with short chains revolve above the disk causing the berries to roll and the projecting parts to engage in the slits. One of these small machines has a capacity of about eight bushels per hour.

The berries are then washed and filled into cans. The principal part of the pack is used by the large pie bakers and jam manufacturers so naturally goes into No. 10 cans. The interspaces are filled with water though a much better product results when a sirup of from 20 to 30 degrees is used. The cans may be either lacquer-lined or plain. A ten-minute exhaust and a like time for cooking is given, the fruit being so acid that it is easily sterilized.

Effect of Varying Degrees of Sirup on Gooseberries in the Cut-out of Fruit and Sirup

<table>
<thead>
<tr>
<th>Weight of fruit 500 grams (17.6 ounces) to No. 2½ can:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of Sirup</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>60</td>
</tr>
</tbody>
</table>

No. 2 can (Washington):

| Density of Sirup | Weight of Contents | Weight of Fruit | Weight of Sirup | Degrees Brix |
| Water           | 575               | 363             | 212             | 2.5          |
| 10              | 579               | 346             | 233             | 9.4          |
| 20              | 584               | 316             | 268             | 13.6         |
| 30              | 604               | 272             | 332             | 19.0         |
| 40              | 625               | 240             | 385             | 24.2         |
| 50              | 627               | 211             | 416             | 28.1         |

No. 2 can (Chicago):

| Density of Sirup | Weight of Contents | Weight of Fruit | Weight of Sirup | Degrees Brix |
| Water           | 590               | 341             | 249             | 5.4          |
| 10              | 593               | 336             | 257             | 10.3         |
| 20              | 613               | 343             | 270             | 13.2         |
| 30              | 611               | 328             | 283             | 18.8         |
| 40              | 632               | 312             | 320             | 23.0         |
| 50              | 647               | 306             | 341             | 28.3         |

Standards (Northwest Canners’ Association)

Fancy Grade. Description: Fruit to be of very fine quality, free from blemishes and uniform in size. Sirup: Per cent of sugar when packed, 60.

Choice Grade. Description: Fruit to be of fine quality, free from blemishes and uniform in size. Sirup: Per cent of sugar when packed, 40.

Standard Grade. Description: Fruit to be of good quality, reasonably free from blemishes, and reasonably uniform in size and degree of ripeness. Sirup: Per cent of sugar when packed, 20.

Second Grade. Description: Fruit to be tolerably free from blemishes and fairly uniform in size. Sirup: Per cent of sugar when packed, 10.

Water or Pie Grade. Description: Wholesome fruit. Sirup: Per cent of sugar when packed, 0.
Label Weights

Fancy (Sp. Gr. 1.10): 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.05): 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

Water (Sp. Gr. 1.01): Picnic—No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 15½ ozs.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs.; No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 5 ozs.

Composition

The composition of gooseberries as given in Circular No. 50 is as follows:

Per Cent

<table>
<thead>
<tr>
<th>Component</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>88.3</td>
</tr>
<tr>
<td>Protein</td>
<td>0.8</td>
</tr>
<tr>
<td>Fat</td>
<td>0.4</td>
</tr>
<tr>
<td>Ash</td>
<td>0.39</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>10.1</td>
</tr>
<tr>
<td>Fiber</td>
<td>2.5</td>
</tr>
<tr>
<td>Sugar</td>
<td>4.2</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>2.32</td>
</tr>
<tr>
<td>Fuel value per 100 grams</td>
<td>47.2</td>
</tr>
<tr>
<td>Fuel value per pound</td>
<td>215.</td>
</tr>
</tbody>
</table>

Loganberry

*Rubus sp.*

This plant is a hybrid resulting from the accidental crossing of the native California blackberry and a red raspberry, believed to be the Red Antwerp, by Judge J. H. Logan, at Santa Cruz, California, in 1881, and fruited in 1882. Judge Logan was an amateur horticulturist interested in hybridizing and while this was not the result of any direct effort, he recognized the strange plant and protected it, and, when its exceptional quality was demonstrated, he donated it to the public through the state university.

The bush possesses the size and general appearance of the blackberry, but the canes have more of the color of the raspberry. It is not very hardy, being injured by severe freezing and killed at zero temperature. It grows well on the West Coast from San Diego to Vancouver and has its optimum bearing in Washington and Oregon.

The fruit exhibits the qualities of both parents, having the size and shape of the blackberry, the color and softer structure of the red raspberry and the flavor of both. The fruit is large, long, cylindrical, red with just a shade of purple, very soft, and juicy when full ripe, strongly acid when immature, but only moderately so when ripe but in all stages more so than either of its parents. An attempt was made to popularize the fruit by extensive advertising at one time, but it is too delicate in structure and too acid in flavor to displace to any extent the established fruits.
It yields abundantly in the Northwest, the statement being made that it often exceeds four tons to the acre. The time of harvesting is from the latter part of May until early in July. The annual pack amounts to about 400,000 cases, 60 per cent of which are packed in No. 2 cans, and 30 per cent in No. 10 cans.

The method of handling and canning is the same as for the blackberry and raspberry.

It requires on an average 21.2 pounds of fresh fruit per case for No. 2 cans; 30.8 pounds for No. 2½ cans, and 50.5 pounds for No. 10 cans.

The Effect of Varying Degrees of Sirup on Loganberries, Weight of Cut-out on Fruit and Sirup

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>570</td>
<td>276</td>
<td>294</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>582</td>
<td>297</td>
<td>295</td>
<td>12.4</td>
</tr>
<tr>
<td>30</td>
<td>606</td>
<td>255</td>
<td>351</td>
<td>21.5</td>
</tr>
<tr>
<td>40</td>
<td>593</td>
<td>297</td>
<td>296</td>
<td>28.3</td>
</tr>
<tr>
<td>50</td>
<td>637</td>
<td>242</td>
<td>395</td>
<td>32.5</td>
</tr>
<tr>
<td>60</td>
<td>650</td>
<td>257</td>
<td>393</td>
<td>38.0</td>
</tr>
</tbody>
</table>

Weight of fruit used, 550 grams (19.5 ounces) in No. 2½ cans:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>818</td>
<td>450</td>
<td>368</td>
<td>7.1</td>
</tr>
<tr>
<td>10</td>
<td>832</td>
<td>472</td>
<td>360</td>
<td>10.6</td>
</tr>
<tr>
<td>20</td>
<td>847</td>
<td>455</td>
<td>392</td>
<td>14.3</td>
</tr>
<tr>
<td>30</td>
<td>856</td>
<td>445</td>
<td>411</td>
<td>19.6</td>
</tr>
<tr>
<td>40</td>
<td>880</td>
<td>460</td>
<td>420</td>
<td>25.4</td>
</tr>
<tr>
<td>50</td>
<td>883</td>
<td>460</td>
<td>423</td>
<td>28.8</td>
</tr>
<tr>
<td>60</td>
<td>900</td>
<td>383</td>
<td>517</td>
<td>33.5</td>
</tr>
</tbody>
</table>

Standards (Northwest Canners' Association)

Fancy Grade. Description: Fruit good size, ripe, but not mushy, uniform, cans well filled. Sirup: Per cent of sugar when packed, 70.

Choice Grade. Description: Practically the same specifications as the foregoing. Sirup: Per cent of sugar when packed, 50.

Water or Pie Grade. Description: Wholesome fruit. Sirup: Per cent of sugar when packed, 0.

Label Weights

Fancy (Sp. Gr. 1.13): 8Z Short, 8½ ozs.; 8Z Tall, 9 ozs.; Picnic—No. 1 East, 11 ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 15 ozs.; No. 10, 7 lbs. 1 oz.

Choice (Sp. Gr. 1.10): 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 10, 6 lbs. 14 ozs.

Standard (Sp. Gr. 1.06): No. 10, 6 lbs. 10 ozs.

Water (Sp. Gr. 1.03): No. 10, 6 lbs. 7 ozs.
Raspberry

*Rubus occidentalis*

While there are several species of raspberry, the common native species, *R. occidentalis*, is the progenitor of the majority of the black varieties or blackcaps and thimbleberries, and *R. strigosus* of the red raspberries of which the Cuthbert is probably the best type. The black raspberry is the more vigorous in growth and the more prolific bearer, the berry is somewhat firmer than the red, generally less acid, and the flavor different. One variety, the Columbia, is especially good for canning, the flavor being rather enhanced by the heating instead of injured as results with most varieties. The red berries are more delicate and to most persons are more attractive than the black. They are considered especially fine for use fresh.

The principal growing sections for producing the fruit for canning is in Washington and Oregon. The pack amounts to nearly 500,000 cases, 50 per cent being packed in No. 2 cans and 35 per cent in No. 10 cans.

**Composition**

The chemical composition of the raspberry does not indicate a high food value, but rather that its chief value lies in the variety and the pleasure which it affords. The following is taken from Circular No. 50, United States Department of Agriculture:

<table>
<thead>
<tr>
<th>Composition</th>
<th>Raspberries</th>
<th>Raspberries</th>
<th>Raspberries</th>
<th>Raspberries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>80.7</td>
<td>88.4</td>
<td>83.4</td>
<td>90.8</td>
</tr>
<tr>
<td>Protein</td>
<td>1.5</td>
<td>1.2</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Fat</td>
<td>1.6</td>
<td>0.0</td>
<td>0.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Ash</td>
<td>.5</td>
<td>.7</td>
<td>.4</td>
<td>.4</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>15.6</td>
<td>10.7</td>
<td>14.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Fiber</td>
<td>3.5</td>
<td>0.0</td>
<td>2.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Sugar</td>
<td>7.9</td>
<td>7.6</td>
<td>7.18</td>
<td>7.3</td>
</tr>
<tr>
<td>Acid, citric</td>
<td>1.16</td>
<td>1.04</td>
<td>1.34</td>
<td>1.4</td>
</tr>
<tr>
<td>Fuel Value, per 100 grams</td>
<td>82.8</td>
<td>43.6</td>
<td>67.4</td>
<td>34.8</td>
</tr>
<tr>
<td>Fuel Value, per pound</td>
<td>375.0</td>
<td>200.0</td>
<td>305.0</td>
<td>160.0</td>
</tr>
</tbody>
</table>

The fruit is picked in shallow trays or boxes not more than one and one-half inches in depth and is transported in chests to prevent any injury. It is imperative that they be brought to the factory promptly so as to be packed the same day or not later than the next following after harvesting. They soften and mold quickly. The veneer boxes should be destroyed at once or at least as soon as they show any stains or indication of contamination.

**Washing**

The berries are washed under fine sprays of water and discharged upon belts where any decayed or unfit material is taken out and the filling of the cans or jars done directly from the belt. A flat scoop can be used with even less injury than occurs where the berries are diverted into bins on a filling table. The can is filled about one-third full, tapped lightly, and the same maneuver repeated at two-thirds and level full. This insures a better fill upon the cut-out and especially with a medium sirup. The individual berries are plumper and firmer than where a heavier sirup is used. A nearly full can may be had by using extension tubes on the cans when filling and exhausting though it involves considerable extra work and slows
down the factory operations. Lacquer-lined cans are a necessity in order to conserve the color and flavor. The berries become pale and flabby with a metallic addition to the flavor when in plain cans. The interspaces are filled with sirup according to the schedule adopted by the Canners' Association.

Exhausting is best carried out by giving from 10 to 12 minutes at 180° F. rather than for a short time at a higher temperature. The fruit is so tender that strong heat causes the cells to expand rapidly and discharge their juice. A good exhaust reduces the number of pinholes and springers. The cooking period is 12 minutes for No. 2, and 14 minutes for No. 2½ cans in a standing open bath.

It requires on an average 20.5 pounds of good fruit for a case of No. 2 cans; 30 pounds for No. 2½ cans; 44.2 pounds for No. 10 cans, sirup grades, and ordinary filling; and 61.5 pounds for No. 10 cans, water grade.

**Effect of Varying Degrees of Sirup Upon Raspberries**

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents (Fruit)</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>595</td>
<td>350</td>
<td>245</td>
</tr>
<tr>
<td>30</td>
<td>620</td>
<td>330</td>
<td>245</td>
</tr>
<tr>
<td>50</td>
<td>630</td>
<td>312</td>
<td>245</td>
</tr>
<tr>
<td>60</td>
<td>630</td>
<td>320</td>
<td>245</td>
</tr>
</tbody>
</table>

| Fruit 380 grams (13.4 ounces) used in No. 2 cans (San Francisco) |
|--------------------|-----------------|----------------|-------------|
| Fruit 600 grams (21.2 ounces) used in No. 2½ cans (San Francisco) |

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents (Fruit)</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>864</td>
<td>550</td>
<td>314</td>
</tr>
<tr>
<td>20</td>
<td>864</td>
<td>558</td>
<td>306</td>
</tr>
<tr>
<td>40</td>
<td>896</td>
<td>504</td>
<td>392</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents (Fruit)</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>556</td>
<td>414</td>
<td>142</td>
</tr>
<tr>
<td>10</td>
<td>565</td>
<td>381</td>
<td>184</td>
</tr>
<tr>
<td>20</td>
<td>577</td>
<td>387</td>
<td>190</td>
</tr>
<tr>
<td>30</td>
<td>590</td>
<td>374</td>
<td>216</td>
</tr>
<tr>
<td>40</td>
<td>579</td>
<td>372</td>
<td>207</td>
</tr>
<tr>
<td>50</td>
<td>598</td>
<td>363</td>
<td>236</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents (Fruit)</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>565</td>
<td>311</td>
<td>254</td>
</tr>
<tr>
<td>10</td>
<td>570</td>
<td>321</td>
<td>249</td>
</tr>
<tr>
<td>20</td>
<td>576</td>
<td>316</td>
<td>260</td>
</tr>
<tr>
<td>30</td>
<td>587</td>
<td>327</td>
<td>260</td>
</tr>
<tr>
<td>40</td>
<td>576</td>
<td>285</td>
<td>291</td>
</tr>
<tr>
<td>50</td>
<td>603</td>
<td>338</td>
<td>265</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents (Fruit)</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>551</td>
<td>363</td>
<td>188</td>
</tr>
<tr>
<td>10</td>
<td>559</td>
<td>354</td>
<td>205</td>
</tr>
<tr>
<td>20</td>
<td>573</td>
<td>344</td>
<td>229</td>
</tr>
<tr>
<td>30</td>
<td>595</td>
<td>318</td>
<td>277</td>
</tr>
<tr>
<td>40</td>
<td>591</td>
<td>306</td>
<td>285</td>
</tr>
<tr>
<td>50</td>
<td>636</td>
<td>284</td>
<td>352</td>
</tr>
</tbody>
</table>
Black Raspberries, 400 grams to No. 2 can (Chicago):

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>545</td>
<td>357</td>
<td>188</td>
<td>6.4</td>
</tr>
<tr>
<td>10</td>
<td>560</td>
<td>354</td>
<td>206</td>
<td>12.2</td>
</tr>
<tr>
<td>20</td>
<td>574</td>
<td>348</td>
<td>226</td>
<td>17.4</td>
</tr>
<tr>
<td>30</td>
<td>576</td>
<td>310</td>
<td>266</td>
<td>23.4</td>
</tr>
<tr>
<td>40</td>
<td>604</td>
<td>301</td>
<td>303</td>
<td>28.4</td>
</tr>
<tr>
<td>50</td>
<td>593</td>
<td>295</td>
<td>298</td>
<td>30.2</td>
</tr>
</tbody>
</table>

Standards (Northwest Canners’ Association)

Red Raspberries:

Fancy Grade. Description: Fruit to be of very fine quality, free from blemishes, and uniform in size. Sirup: Per cent of sugar when packed, 60.

Choice Grade. Description: Fruit to be of fine quality, free from blemishes, and uniform in size. Sirup: Per cent of sugar when packed, 40.

Standard Grade. Description: Fruit to be of good quality, reasonably free from blemishes, and reasonably uniform in size and degree of ripeness. Sirup: Per cent of sugar when packed, 20.

Second Grade. Description: Fruit to be tolerably free from blemishes and fairly uniform in size. Sirup: Per cent of sugar when packed, 10.

Water or Pie Grade. Description: Wholesome fruit. Sirup: Per cent of sugar when packed, 0.

Black Raspberries:

Fancy Grade. Description: Fruit to be of very fine quality, ripe, free from blemishes, and uniform in size. Sirup: Per cent of sugar when packed, 40.

Choice Grade. Description: Fruit to be of fine quality, ripe, free from blemishes, and uniform in size. Sirup: Per cent of sugar when packed, 30.

Standard Grade. Description: Fruit to be of good quality, reasonably free from blemishes, and reasonably uniform in size and degree of ripeness. Sirup: Per cent of sugar when packed, 20.

Second Grade. Description: Fruit to be tolerably free from blemishes, and fairly uniform in size. Sirup: Per cent of sugar when packed, 10.

Water or Pie Grade. Description: Wholesome fruit. Sirup: Per cent of sugar when packed, 0.

Label Weights

Red Raspberries:

Fancy (Sp. Gr. 1.10): 8Z Short, 8 ozs.; 8Z Tall, 8 3/4 ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 1/2 ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2 1/2, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08): 8Z Short, 8 ozs.; 8Z Tall, 8 3/4 ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2 1/2, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Standard (Sp. Gr. 1.05): 8Z Short, 7 3/4 ozs.; 8Z Tall, 8 1/2 ozs.; Picnic—No. 1 East, 10 1/2 ozs.; No. 300, 14 1/2 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2 1/2, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.
Water (Sp. Gr. 1.03): Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 7 ozs.

Black Raspberries:

Fancy (Sp. Gr. 1.09): Same as Red, except No. 5, 3 lbs. 11 ozs., and No. 10, 6 lbs. 13 ozs.

Choice (Sp. Gr. 1.06): 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Standard (Sp. Gr. 1.05): Same as for Red.

Water (Sp. Gr. 1.02): Picnic—No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 6 ozs.

Strawberry

Fragaria virginiana

This plant is represented in the native flora of Europe and both the Americas though by different species. It is not old as a cultivated plant, the earliest domestication only about 600 years ago and started in France. No notable progress either in its development or use was made, however, during the first four centuries. Our native strawberry was carried to Europe early in the 17th century and a Chilean variety a century later. These added nothing of value directly though they contributed to the hybridization which gave Europe its present garden variety. The intensive cultivation did not begin until about the beginning of the 19th century.

The history of the domestication of the plant in this country is somewhat similar to that abroad. The early settlers found the fruit in such abundance and of such excellence that no attempt was made at cultivation until about 1800 and then only near large cities like Boston, New York, Philadelphia, and Baltimore. A slow extension of the culture occurred as the cities increased in population and it became less convenient to gather the wild fruit. It was about the middle of the century that new and improved varieties began to appear as a result of added attention. After the Civil War, varieties were developed very rapidly and a strange boom occurred in the propagation of this fruit. Prices for new and improved plants went up like those for Dutch tulips but a collapse came in the eighties though it left a heritage of general knowledge and appreciation of the fruit which has since held it in the first rank of berries. During this period about 1,500 varieties are alleged to have been developed but less than two per cent had sufficient merit to survive more than a few years.

The Plant

The strawberry is an herbaceous perennial, small, usually less than 10 inches in height, and propagates itself by short runners. The leaves are three-parted, rather rough, with serrated edges; the flowers are white, mostly in clumps and sterile. The fruit varies much in size and shape. from
less than a half-inch to more than an inch and a half in diameter, made up of many small abortive seeds and the coalescence of the pulpy base; generally red in color and with a fine flavor. The fruit is very tender so that it requires both care and protection in handling and remains in good condition for only a short time. The plant thrives best on a rather light, moderately moist soil, and is short lived, the beds usually being replaced every two or three years.

Cultivation has resulted in an increase in the size of the plants and fruit, in better production, and extension of the bearing period but in most cases with some impairment of its original flavor. The wild berry is peculiarly rich in flavor and odor of a most delicate kind, qualities poorly developed in large pulpy fruit. The qualities which do remain are injured by the high temperature necessary for sterilization and the appearance is also altered so that its best qualities are evident only in the fresh fruit; next to that is conservation with sugar in the form of a jam.

The plant is widely grown in both home and commercial gardens, but the large commercial producing sections are in the South and the Northwest near the coast. The former section produces chiefly for the fresh market and the latter for cold packing, preserving, and canning.

The varieties most suitable for canning and manufacturing processes are those with moderate sized fruit, firm, with high color, and above the average in acidity. Soft berries of large size shrink unduly, lose their shape and become unattractive. A fairly heavy sirup is necessary for them to hold their shape, so for that reason a high acidity is beneficial in overcoming the excessive sweetness due to the sugar.

Harvesting

Since the strawberry is inherently tender, it was necessary to develop special methods for handling it and these have since been applied to other berries. The berries are picked with the stems attached and handled only in shallow boxes or trays. In the East the box is most used as it is the unit for distribution in the fresh trade and very naturally followed in the packing. The quart and pint are the two sizes most used and of these the quart is a little too deep for the best results. After rains, when the fruit is soft, during very hot weather, or if it be necessary to carry the fruit over night, the inside and bottom layers in quart boxes show more deterioration than do similar lots of berries when held in flat trays. The box packing shows its chief advantage in that thirty-two make a very compact and light crate. The chest or drawer system is a western development in which the fruit is handled in flat boxes not more than one and one-half inches in depth with twenty-four trays or drawers filled into a rigid chest. The drawers slip into guides so that they are held firmly in position without danger of any pressure upon the fruit. It is the best protective system yet developed, but is heavier to handle than the crate.

The berries may be picked directly into the boxes or trays and thus avoid any further handling or they may be picked into shallow boxes and transferred at an inspection table. The latter is not necessary for canning fruit if good pickers be employed, neither is there any advantage in facing the fruit.
U. S. Standards for Growers’ Stock Strawberries for Manufacture  
(Effective June 1, 1935)

Introduction

These standards are intended for use only as a basis for determining the quality of strawberries as they are delivered by the growers to the manufacturing plant. The requirements of the standards are not applicable nor is it intended that they shall apply to strawberries which have been washed and graded for barreling or packaging for market.

Buying and selling on the basis of uniform standards encourages better production and better handling methods. The practice of paying a flat price for all strawberries which are accepted discriminates against the best growers. The growers should be paid a suitable premium for strawberries which will make a high quality manufactured product. Likewise the grower should be penalized for the delivery of low quality berries.

It should be understood at the outset that in the application of these standards the only sorting required of the grower is the removal of cull berries. The standards provide a basis for sampling lots as they are delivered by the growers.

There are two methods suggested for applying the standards as a measure of quality of growers’ deliveries. The manufacturer may contract with growers to pay a certain price per pound according to the actual percentage of the U. S. No. 1 berries delivered, or at a certain price per pound for strawberries of each grade with the respective tolerances. In the first method the contract would disregard all tolerances and also U. S. No. 2, U. S. No. 3, and U. S. No. 4 grades.

To illustrate the first method of applying the standards, suppose the contract specifies that the manufacturer agrees to pay at the rate of 6 cents per pound according to the actual percentage of the U. S. No. 1 berries delivered. The inspector takes a representative sample from a 300 pound lot of strawberries and finds that 93 per cent of the berries, by weight, meet U. S. No. 1 requirements. Therefore, the lot would be settled for at the rate of 6 cents per pound for 93 per cent of 300 pounds (279 pounds) or $16.74 for the 300 pound lot. Similarly a 300 pound lot having 85 per cent of U. S. No. 1 berries would be settled for at the rate of 6 cents per pound for 85 per cent of 300 pounds (255 pounds) or $15.30 for the 300 pound lot.

To illustrate the second method, suppose the contract specified that the manufacturer agrees to pay 6 cents per pound for U. S. No. 1 berries, 5 cents per pound for U. S. No. 2 berries, 4½ cents per pound for U. S. No. 3 berries, and 4 cents per pound for U. S. No. 4 berries. The inspector takes a representative sample from a 300 pound lot of strawberries and finds that 96 per cent of the berries, by weight, meet U. S. No. 1 requirements. Therefore, the lot would be settled for at the rate of 6 cents per pound for 96 per cent of 300 pounds (270 pounds) or $16.74 for the 300 pound lot. Similarly a 300 pound lot having 85 per cent of U. S. No. 1 berries would be paid for at the rate of 6 cents per pound for 85 per cent of 300 pounds (255 pounds) or $15.30 for the 300 pound lot.

To illustrate the second method, suppose the contract specified that the manufacturer agrees to pay 6 cents per pound for U. S. No. 1 berries, 5 cents per pound for U. S. No. 2 berries, 4½ cents per pound for U. S. No. 3 berries, and 4 cents per pound for U. S. No. 4 berries. The inspector takes a representative sample from a 300 pound lot of strawberries and finds that 96 per cent of the berries, by weight, meet U. S. No. 1 requirements. Since a tolerance of 5 per cent is allowed for this grade such a lot would grade U. S. No. 1 and would be paid for at the rate of 6 cents per pound. Therefore, the 300 pound lot would bring $18.00.

If the inspector found the lot to contain 11 per cent defective berries it would grade U. S. No. 3 and would be paid for at the rate of 4½ cents per pound. In this case the 300 pound lot would bring $13.50.

The foregoing prices are used for illustrative purposes only.

The application of these standards requires the services of private or official inspectors to determine and report the grade of each lot of strawberries delivered to the factory. Such inspectors must be capable, efficient and above all they must be absolutely neutral.

Grades

U. S. No. 1 shall consist of strawberries of one variety which are well colored, free from mold and decay and from soft, badly crushed or split, dried or undeveloped berries and from damage caused by dirt or other foreign matter, hail, sunscald, birds, disease, insects, mechanical or other means. Unless otherwise specified, the minimum size shall be not less than ½ inch in diameter and the caps shall be entirely removed.

In order to allow for variations incident to proper handling, not more than 5 per cent, by weight, of the strawberries in any lot may be below the requirements of this grade.

U. S. No. 2 shall consist of strawberries which meet all the requirements of U. S. No. 1 grade except that a tolerance of 10 per cent, by weight, of the strawberries in any lot shall be permitted for grade defects.
U. S. No. 3 shall consist of strawberries which meet all the requirements of U. S. No. 1 grade except that a tolerance of 15 per cent, by weight, of the strawberries in any lot shall be permitted for grade defects.

U. S. No. 4 shall consist of strawberries which meet all the requirements of U. S. No. 1 grade except that a tolerance of 20 per cent, by weight, of the strawberries in any lot shall be permitted for grade defects.

Unclassified shall consist of strawberries which do not meet the requirements of any of the foregoing grades.

Definitions of Terms

As used in these standards:

“Well colored” means that at least four-fifths of the surface of the berry is covered with red or pink color.

“Soft” means that more than one-third of the volume of the whole berry is mushy or will be removed in the ordinary process of washing.

“Dried” means appreciably lacking in juice. Dried berries are excessively seedy and often shriveled.

“Undeveloped” means lack of development due to frost or insect injury, lack of pollination or other means which causes the berry to be badly misshapen.

“Damage” means any injury or defect which materially affects the appearance or edible quality of the berry for manufacturing purposes.

“Damage by dirt” means that the berry shows dirt which will not wash off in the ordinary process of washing.

“Diameter” means the greatest dimension measured at right angles to a straight line running from the stem to the apex.

Canning

If the berries are warm when brought to the factory, it is advantageous to run them into a chill room for two or three hours to cause them to become firm before handling. The stemming or capping is a hand operation that is difficult to carry out on soft fruit. The stemming is done directly from the boxes and the fruit handled in shallow enamel pans to prevent mashing. Those who do this work also do the inspecting by taking out any defective material, and in addition, the green and small berries from stock intended for choice or fancy grades.

The pans of fruit are carried to the washer on conveyors in the large factories but in mounted racks in the smaller ones. The Haller berry washer is the one most used for cleaning and up to date the most satisfactory one developed for the purpose. The fruit is dumped into water above a perforated conveyor and a paddle underneath causes an up and down movement to the water which loosens and gets rid of sand and soil. As the fruit is carried along on the conveyor, it is sprayed with fine jets of water to get rid of foreign matter and this done in a gentle yet effective manner.

The berries may be discharged from the washer upon a rubber conveyor belt from which they can be taken up and filled into cans or they may be delivered into shallow enamel pans and carried to the canning tables. The filling of the cans from the belt may be done with a flat scoop, or flattened funnels may be attached along the side of the conveyor table and diversion gates be used to cause the berries to run into the funnel and the can. In some ways the use of the scoop is preferable, as the can or jar may be filled about one-third full, then given a light tapping upon the table to cause the berries to settle, then to repeat the operation when about two-thirds full and when full. If the can is loosely filled or without any tapping, it shows a slack fill upon opening. Even by tapping, the fruit is so
softened and then settled together by the cooking that the container will not be more than two-thirds full of solids.

In another method, one-third of the sugar desired in a can is added to begin with, then one-third of the berries, followed by another third of the sugar and berries, and finally the last portion of sugar and berries. This requires that an extension tube be placed on the can and left in place during the exhausting. A slow exhaust is given during which the fruit collapses to a certain extent, the juice escapes and forms a sirup by uniting with the sugar, the final result being a can nearly full of fruit and with the maximum of flavor.

Strawberries have considerable quantities of air or gas incorporated within their tissues so need a long low exhaust, 10 minutes or more at 175° to 180° F. In the absence of a good exhaust, they become pale, and springers and pinholing of the cans follow in a comparatively short time. Sterilization is easy as a cook of 10 minutes at boiling is sufficient for No. 2½ cans and under. Cooling needs to follow promptly in order to preserve the best appearance in form and color. Inside lacquered cans should be used as there is almost total loss of color in plain cans with an acquired distinctly metallic flavor.

It requires on an average, 24 pounds of good fruit per case for No. 2 cans; 31.5 pounds per case for No. 2½ cans; and 63 pounds per case for No. 10 cans.

The Effect of Varying Degrees of Sirup on Strawberries and the Cut-out Weight of Fruit and Sirup

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>773</td>
<td>370</td>
<td>403</td>
<td>6.5</td>
</tr>
<tr>
<td>10</td>
<td>800</td>
<td>308</td>
<td>492</td>
<td>10.2</td>
</tr>
<tr>
<td>20</td>
<td>815</td>
<td>328</td>
<td>487</td>
<td>14.2</td>
</tr>
<tr>
<td>30</td>
<td>835</td>
<td>337</td>
<td>498</td>
<td>19.2</td>
</tr>
<tr>
<td>40</td>
<td>845</td>
<td>348</td>
<td>497</td>
<td>24.2</td>
</tr>
<tr>
<td>50</td>
<td>867</td>
<td>358</td>
<td>509</td>
<td>28.6</td>
</tr>
<tr>
<td>60</td>
<td>880</td>
<td>357</td>
<td>523</td>
<td>35.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>544</td>
<td>225</td>
<td>319</td>
<td>5.9</td>
</tr>
<tr>
<td>10</td>
<td>546</td>
<td>210</td>
<td>336</td>
<td>9.4</td>
</tr>
<tr>
<td>20</td>
<td>554</td>
<td>208</td>
<td>346</td>
<td>13.1</td>
</tr>
<tr>
<td>30</td>
<td>587</td>
<td>209</td>
<td>378</td>
<td>18.5</td>
</tr>
<tr>
<td>40</td>
<td>576</td>
<td>210</td>
<td>366</td>
<td>22.2</td>
</tr>
<tr>
<td>50</td>
<td>587</td>
<td>212</td>
<td>375</td>
<td>26.1</td>
</tr>
<tr>
<td>60</td>
<td>604</td>
<td>188</td>
<td>416</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Standards (Northwest Canners’ Association)

Fancy Grade. Fruit to be of very fine quality, free from blemishes and uniform in size. Sirup: Per cent of sugar when packed, 60.

Choice Grade. Fruit to be of fine quality, free from blemishes and uniform in size. Sirup: Per cent of sugar when packed, 40.

Standard Grade. Fruit to be of good quality, reasonably free from blemishes, and reasonably uniform in size and degree of ripeness. Sirup: Per cent of sugar when packed, 20.
Second Grade. Fruit to be tolerably free from blemishes and fairly uniform in size. Sirup: Per cent of sugar when packed, 10.

Water or Pie. Wholesome fruit. Sirup: Per cent of sugar when packed, 0.

Composition

The composition of the fruit and juice as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th>Components</th>
<th>Fruit</th>
<th>Juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>90.0</td>
<td>94.2</td>
</tr>
<tr>
<td>Protein</td>
<td>.8</td>
<td>.2</td>
</tr>
<tr>
<td>Fat</td>
<td>.6</td>
<td>.0</td>
</tr>
<tr>
<td>Ash</td>
<td>.5</td>
<td>.45</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>8.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Sugars</td>
<td>5.27</td>
<td>3.63</td>
</tr>
<tr>
<td>Acid, as citric</td>
<td>1.09</td>
<td>1.01</td>
</tr>
<tr>
<td>Fuel value per 100 grams</td>
<td>41.</td>
<td>21.2</td>
</tr>
<tr>
<td>Fuel value per pound</td>
<td>185.</td>
<td>95.</td>
</tr>
</tbody>
</table>

CHERRY

Prunus cerasus, P. avium

The cultivated cherries seem to have been developed from two species: one, Prunus cerasus, native to the forests south of the Caucasus Mountains and from which point it was distributed to southern Europe and later to the Orient. This species is the one from which have been developed the principal varieties of sour cherries eaten fresh and used in cooking. It is said that this was brought to Rome by Lucullus about 60 years B. C., but other writers contend that the fruit brought was only some large variety and that the species must have been known before that time, though the terminology does not make it possible to distinguish it from the second species, Pr. avium, which is native to most of Europe, particularly the southeastern part of Greece and the Balkans, and the Dalmatian mountains. The latter is a naturally small cherry, dark, and not pleasing when eaten raw. It does have an important use as furnishing the basic ingredient for Kirsch or Kirschwasser in Germany and Maraschino flavor in Italy and France. The Bigarreau, Black Heart, and other sweet varieties are supposed to have descended from it. These varieties as well as the Morello and Montmorency are old for they are referred to by Evelyn in the latter part of the 17th century as being brought to England from Holland but that the Dutch had gotten them from France, though in reality they originally came from Spain.

Both of these strains of cherries were brought from abroad. The sour cherry is grown practically everywhere south of a line drawn from Nova Scotia to Vancouver, and is one of the most widely distributed fruit trees. The sweet strains are little grown except on the West Coast, are less hardy than the sour, and more exacting as to their soil requirements if they bear a crop.
Sour Cherries

The commercial production of sour cherries is carried on chiefly in New York, Michigan, and Wisconsin, or near the Great Lakes where the weather is tempered to some extent by the water and thus the frost hazard lessened. Within the past few years considerable quantities have been grown in Colorado. The cherry develops flowers early in the spring before the leaves so that it is predisposed to injury from frost.

The center of the sour cherry canning at present is near Sturgeon Bay, Wisconsin. A single orchard has more than 30,000 trees and 80 tons of fruit have been harvested in one day; more cherries than were packed in an entire season by some of the better packers twenty years ago. It requires from 750 to 1,000 persons to do the picking.

The pack of the sour cherry was relatively small, but has been increasing, and in 1931 amounted to 1,400,000 cases.

The cherry tree is attractive, grows to a height of twenty feet or more, is rather loose and open, with dark but smooth bark. The white flowers are in clumps close to the branches. The fruit is globular or flattened, from bright to dark red, smooth and shiny, pit small and globular with some flattening from side to side. The two important varieties are the Montmorency and Early Richmond, the fruit light red and three-quarters of an inch in diameter. The time of harvesting in the Lake Region is in June and July. The trees are generally set about 20 feet apart each way and preferably upon fairly high ground that is well drained. They are pruned so that picking can be done from short ladders. The tree is not long lived and orchards require about ten per cent annual replacement.

The harvesting is wholly hand work and done when the fruit is fully ripe. If under-ripe, the flavor has a peculiar bitter tang, and if too far advanced, the fruit softens and cracks. The time when the work can be done is short so that the exposed fruit showing most advancement is taken as early as possible and that on the interior and shady side a few days later. In large orchards with varying exposure on rolling land, the picking time will extend over a period of from twenty to thirty days.

Formerly all picking was done with the stems attached, a practice which seemingly grew up in gathering for the fresh market as the stem prevented bleeding of juice and retarded infection from mold. For canning, however, it is better that the fruit be taken when a little riper so that the pit separates from the stem which makes picking easier and also saves one operation in the factory. There will be little bleeding, and as the time from picking to canning is only a few hours, mold does not have a chance to start, and contrary to the older belief, the trees are not injured nearly so much as by leaving the stems on. The succeeding crops are equally heavy and good in quality as when the stems were removed.

The pickers most often wear a belt with snaps to carry a gallon bucket in order to have the use of both hands and to work with such a small quantity, minimizes crushing. A good picker gathers about two gallons per hour. The buckets are emptied into special cherry lug boxes 20 inches long, 15 inches wide, and 6 inches deep to hold 20 pounds, then loaded on the wagons and taken to the factory. Since the season is short and pickers have to be recruited for the work, it is customary to put in long hours and
pick from 20 to 25 gallons, as payment is made on a quantity basis. The boxes are collected at short intervals so that it is claimed by a large canner that not more than an hour elapses between the picking of the fruit and the arrival at the factory.

U. S. Standards for Red Sour Cherries for Manufacture (1931)

Grades

U. S. No. 1 shall consist of cherries which are fairly well colored, free from decay, stems, and worms, and from damage caused by pulled pits, hail, bird pecks, sunscald, shriveling, windwhips, limbrubs, scars, foreign material, disease, mechanical or other means. Unless otherwise specified, each cherry shall have a diameter of not less than \( \frac{5}{8} \) inch.

In order to allow for variations incident to proper handling, not more than 5 per cent, by count, of the cherries in any lot may be below the requirements of this grade but no part of this tolerance shall be allowed for cherries which are affected by worms.

U. S. No. 2 shall consist of cherries which meet all the requirements of U. S. No. 1 grade except that a tolerance of 10 per cent, by count, of the cherries in any lot shall be permitted for grade defects but no part of this tolerance shall be allowed for cherries which are affected by worms.

U. S. No. 3 shall consist of cherries which meet all the requirements of U. S. No. 1 grade except that a tolerance of 15 per cent, by count, of the cherries in any lot shall be permitted for grade defects but no part of this tolerance shall be allowed for cherries which are affected by worms.

U. S. No. 4 shall consist of cherries which meet all the requirements of U. S. No. 1 grade except that a tolerance of 20 per cent, by count, of the cherries in any lot shall be permitted for grade defects but no part of this tolerance shall be allowed for cherries which are affected by worms.

Unclassified shall consist of cherries which do not meet the requirements of any of the foregoing grades.

Definitions of Terms

As used in these grades:

"Fairly well colored" means that the cherry may be light red to dark red in color, but shall not be of whitish-pink color.

"Damage" means any injury which materially affects the appearance or edible quality of the cherry. Light colored scars or scars which do not materially discolor the flesh beneath the skin shall not be considered as damaged. Cherries from which the pits have been removed in the process of harvesting shall be regarded as damaged.

"Diameter" means the greatest dimension, measured through the center of the cherry at right angles to a line running from the stem end to the blossom end.

Canning

Canning is a comparatively simple operation and requires little help by comparison with the picking. If the cherries be picked without stems, they are dumped from the boxes directly into cold water to chill them in order to make them firm for the pitter. Cold water is circulated in the tanks so that the temperature of the fruit is reduced to about 50 degrees in a half hour. Holding in the water for a little time has other effects; that of thoroughly washing them which is important in removing any trace of spray which may have dried on the surface, and floating off any wormy or green fruit which have been inadvertently taken.

If the gathering be done with stems attached, the fruit is run over a stemming machine which consists of long inclined rolls set in pairs. Above the rolls is a hollowed plate with a slit in the center. As the cherry slides down, the stem pushes through the slit and gets caught by the rolls and pulled out. The cherry rolls over the end and is carried on a conveyor or
chute to the washing tank. The tank is divided into three or four compartments so that the fruit may be held for a definite time and all lots be treated uniformly. When the tank system is not used, the washing is done under sprays but is not so effective.

The washed fruit passes over an inspection table where women pick out those with stems attached or otherwise defective from any cause, as wilt, double pits, etc., and these combined constitute about 4.5 per cent. As there is no grading for size, all the fruit is delivered directly to the pitting machine. The cherries are fed from a hopper to a drum having rows of cups on its surface to hold each fruit in position and to align it directly under the row of plunger pins which force the pits out of the cherry through a hole in the bottom of the cup and into the interior of the drum. The plunger is made with a star-shaped cutting head so there is a minimum of injury. The machines are made of various sizes, to pit from 10 to 50 cherries at a time. The largest size will pit at the rate of 4,200 cherries per minute or 1,200 pounds per hour, and six machines are used in the plant already referred to. As the drum turns over, the pitted fruit falls upon a rubber belt conveyor and is carried to the filling table, which is usually of the revolving hand-filler type. The final check on the fill is made by adjusting the weight, which should be done with considerable accuracy.

The pitting machine is capable of doing nearly perfect work, not leaving more than one pit in a No. 2 can or more than ten in a No. 10 can. The presence of a large number of pits in cherries is evidence of carelessness in adjustment or operation, or the use of a machine not adapted to the stock. A machine designed for pitting sour cherries does not work satisfactorily on the larger sweet cherries and vice versa.

The cans are exhausted from 10 to 12 minutes in a steam exhaust, or 12 to 15 minutes in a hot water exhaust, in order to free them of air and gas. A good deal of air is pocketed in the pit space and unless removed by the exhaust will appear in the can as head space and may also have a bad effect in pinholing. The long steam exhaust causes the fruit on the top to shrivel and brown which detracts from its appearance so that there is an advantage in using the water exhaust. The aim is to get the temperature at the center of the can close to 150°. To go above this point on No. 10 cans causes an excessive amount of collapse, though it may be carried to 165° in No. 2 cans with benefit. The high acidity of the cherry makes sterilization easy so that 10 minutes in an agitating cooker at boiling temperatures suffices and is then followed by cooling to atmospheric temperature. Cooking in an open bath requires about 20 minutes owing to the fact that the heat currents are irregular and slow. Inside enamel cans are used so as to preserve the color. Only about 20 per cent of the pack is put in No. 2 cans.

Cherries lose some of their juice upon cooking so that a cut-out of 72 ounces for a No. 10 can will require that from 92 to 94 ounces of fruit be weighed in, and for a 78 ounce cut-out from 100 to 104 ounces be used. The drained weight immediately after packing will be about 2 to 3 ounces less than 15 days later.

Another method is to kettle-cook the cherries with sugar for 5 to 6 minutes. The cherry is so acid that sugar is necessary to make it acceptable, and by adding about 20 per cent this is attained and, in addition, the tissues
are made firm and so improve the appearance. Kettle-cooking slows down the operation somewhat as the cans are filled by means of perforated ladles, these being used so that the proper quantity of solid fruit is obtained; then the sirup added. No exhaust is given as the desired effect is obtained by the short cooking with sugar. The cans are cooked 8 minutes in an agitating cooker.

The surplus juice and sirup are concentrated and used by confectioners for flavoring ices, ice cream, etc. The pits, which constitute about 15 per cent of the fruit, are washed, dried, and used as a source of flavoring oil.

It requires from 85 to 100 pounds of raw fruit, depending upon the season and condition of the fruit (also upon the filling), to make a case of one dozen No. 10 cans, and 29 to 32 pounds to make a case of two dozen No. 2 cans. A No. 10 can will cut out from 72 ounces, for light fill, to 84 ounces, for heavy fill.

**Label Weights, Pitted Fruit**

- **Kettled (Sp. Gr. 1.20):** 8Z Short, 8¾ ozs.; 8Z Tall, 9½ ozs.; Picnic—No. 1 East, 12 ozs.; No. 300, 1 lb. 1 oz.; No. 1 Tall, 1 lb. 2 ozs.; No. 303, 1 lb. 2 ozs.; No. 2 Special, 1 lb. 6 ozs.; No. 2, 1 lb. 7 ozs.; No. 2½, 2 lbs. 1 oz.; No. 3, 2 lbs. 6 ozs.; No. 5, 4 lbs. 1 oz.; No. 10, 7 lbs. 8 ozs.

- **Fancy (Sp. Gr. 1.10):** 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

- **Choice (Sp. Gr. 1.07):** 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 11 ozs.

- **Standard (Sp. Gr. 1.05):** 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

- **Water (Sp. Gr. 1.03):** Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 7 ozs.

**TENTATIVE UNITED STATES STANDARDS FOR GRADES OF CANNED RED SOUR PITTED CHERRIES**

(February 21, 1935)

**Definition**

CANNED RED SOUR PITTED CHERRIES are the product prepared from properly matured fruit of the cherry tree (Prunus Cerasus) of the red sour varieties, after having been properly stemmed and pitted, packed in their natural juice and/or water, with or without added sugar or sugar sirup, packed in hermetically sealed containers and sterilized by heat.

**Grades of Canned Water Pack Red Sour Pitted Cherries**

*U. S. Grade A (Fancy)* canned water pack red sour pitted cherries are canned cherries of similar varietal characteristics; are uniformly red in color; are practically uniform in size, not to exceed 5 per cent by count being less than ¾ inches in diameter; are practically free from defects; have a firm, fleshy texture; possess a normal red sour cherry flavor; and score not less than 85 points when scored according to the scoring system outlined herein.


U. S. Grade C (Standard) canned water pack red sour pitted cherries are canned cherries of similar varietal characteristics; are uniformly red in color; are fairly uniform in size, not to exceed 20 per cent by count being less than \( \frac{1}{3} \) inches in diameter; are fairly free from defects; have a fairly fleshy texture; possess a normal red sour cherry flavor; and score not less than 70 points and not more than 84 points when scored according to the scoring system outlined herein.

Substandard canned water pack red sour pitted cherries are canned cherries that fail to meet the requirements of the foregoing grades, or when any one of the grading factors, with the exception of UNIFORMITY OF SIZE, falls in the subdivision D, or canned red sour pitted cherries that fall below the standard promulgated under the terms of section 8, paragraph 5 of the Federal Foods and Drugs Act.

Prerequisites to Grading

FILL OF CONTAINER—Cans of red sour pitted cherries shall be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container, and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned water pack red sour pitted cherries that do not meet the above requirements shall bear the legend,

“Below U. S. Standard—Good Food, Not High Grade”
“ Slack Fill”

Official certificates of grade shall show the drained net weight of cherries in connection with the statement of grade. For example,

“GRADE: U. S. Grade C (Standard)—72 ounces drained net weight”

Added liquid is excessive in canned cherries when the weight of fruit placed in the container is less than 60 per cent of the weight of water which the sealed container will hold at 68° F.

A certificate of grade covering canned water pack red sour pitted cherries that do not meet the above requirements in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend.

“Below U. S. Standard—Slack Fill”
“Contains Excess Added Liquid”

EXPLANATION—“Pitted” means that all pits have been removed from the fruit, with a tolerance provided, however, of not to exceed 1 pit or its equivalent in broken pieces of pits in each 10 ounces of net contents.

A certificate of grade covering canned water pack red sour pitted cherries that do not meet the above requirement shall bear, in addition to the Substandard legend herebefore mentioned, the following additional explanatory statement:

“Partly Pitted Cherries”

“Diameter” means the greatest dimension measured through the center of the cherries at right angles to a line running from the stem end to the blossom end.

DRAINED NET WEIGHT AND HEAD SPACE REQUIREMENTS—Drained net weights of red sour pitted cherries are determined by emptying the contents of the can upon a circular sieve of proper diameter containing 8 meshes to the inch (0.097-inch perforations), and allowing to drain for 2 minutes. The sieve diameters used are: 8 inches for No. 2 size cans, and 12 inches for No. 10 size cans.

The minimum drained net weight and the maximum head space allowable in the sizes commonly used in packing canned water pack red sour pitted cherries are shown in the accompanying table.

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum Head Space Allowable</th>
<th>Minimum Dr. Net Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(measured from top of double</td>
<td>(in ounces)</td>
</tr>
<tr>
<td></td>
<td>seam in 16ths of an inch)</td>
<td></td>
</tr>
<tr>
<td>No. 2</td>
<td>9.7</td>
<td>13.0</td>
</tr>
<tr>
<td>No. 10</td>
<td>13.6</td>
<td>72.0</td>
</tr>
</tbody>
</table>

Ascertaining the Grade

The grade of canned water pack red sour pitted cherries may be ascertained by considering, in addition to the foregoing requirements, the following factors: Color, uniformity of size, absence of defects, character of fruit, and flavor. The relative...
importance of each element has been expressed numerically on a scale of 100. The
maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color ............................................... 25</td>
</tr>
<tr>
<td>II. Uniformity of size................................. 10</td>
</tr>
<tr>
<td>III. Absence of defects............................... 25</td>
</tr>
<tr>
<td>IV. Character of fruit............................... 25</td>
</tr>
<tr>
<td>V. Flavor ............................................... 15</td>
</tr>
</tbody>
</table>

Total.................................................................. 100

ASCERTAINING THE RATING OF EACH FACTOR—The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 21 to 25 means 21, 22, 23, 24, and 25.

I. COLOR—The factor of color has reference to the intensity of the natural red color of the canned cherries.

(A) Cherries that possess the typical red color of fully matured red ripe sour cherries may be given a credit of 21 to 25 points.

(C) If the cherries have only a fairly good color, a credit of 18 to 20 points may be allowed. Cherries that fall in this classification shall not be graded above U. S. Grade C (Standard) regardless of the total score for the product.

(D) If the cherries are decidedly "off" color for any reason, a credit within the range of 0 to 17 points may be allowed.

II. UNIFORMITY OF SIZE.

(A) To receive a rating within the highest group, 9 to 10 points, for the factor of uniformity of size, cherries must be practically uniform in size, not to exceed 5 per cent by count being less than \( \frac{1}{8} \) inches in diameter.

(C) If the cherries are fairly uniform in size, a credit of 7 to 8 points may be allowed.

(D) If the cherries are noticeably lacking in uniformity of size, a credit within the range of 0 to 6 points may be allowed.

III. ABSENCE OF DEFECTS—The factor of absence of defects has reference to such defects as limb-rubs, scars, scabs, wind whips, spray scald, stems, pathological defects, insect injuries, and leaf tissues. The presence of mutilated or pitter torn cherries is to be considered in this connection. Units showing surface discolorations free from mold having a total area of a circle \( \frac{3}{8} \) inches in diameter, or less, with no perceptible discoloration of the fruit tissue under the skin, will not be considered as blemished.

(A) If the cherries are practically free from such defects and/or blemishes, a credit of 21 to 25 points may be allowed.

(C) If the defects and/or blemishes are prominent, a credit of 17 to 20 points may be allowed.

(D) If the defects and/or blemishes are decidedly prominent, or when there is present more than one cherry pit, or its equivalent in broken pieces, per each 10 ounces of net contents, or when there is in excess of 20 per cent of blemishes, a credit within the range of 0 to 16 points may be allowed.

IV. CHARACTER OF FRUIT—In the factor of character of fruit, consideration is given to the texture of the fruit, ripeness, firmness and tenderness of the cherry as a whole.

(A) To receive a rating within the highest group, 21 to 25 points, for this factor, the fruit must have a good texture, being firm and tender.

(C) If the fruit is somewhat lacking in firmness and tenderness, a credit of 17 to 20 points may be allowed.

(D) If the fruit is soft, tough, or leathery, a credit within the range of 0 to 16 points may be allowed.

V. FLAVOR.

(A) If the cherries possess the fine distinct flavor of properly ripened cherries, a credit of 13 to 15 points may be allowed.

(C) If the cherries possess a fairly good flavor, a credit of 11 to 12 points may be allowed.

(D) If the fruit possesses an "off" flavor, or is distinctly disagreeable to the taste for any reason, a credit within the range of 0 to 10 points may be allowed.
Composition

Circular No. 50 of the Department of Agriculture gives the composition of cherries as follows:

<table>
<thead>
<tr>
<th></th>
<th>Sour Cherries</th>
<th>Sweet Cherries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Water</td>
<td>84.4</td>
<td>80.0</td>
</tr>
<tr>
<td>Protein (N x 6.25)</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Fat</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Ash</td>
<td>5.1</td>
<td>5.6</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>13.3</td>
<td>17.8</td>
</tr>
<tr>
<td>Fiber</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Sugars as invert</td>
<td>9.5</td>
<td>11.6</td>
</tr>
<tr>
<td>Acid as malic</td>
<td>1.38</td>
<td>.68</td>
</tr>
<tr>
<td>Fuel value per 100 grams</td>
<td>62.9</td>
<td>80.1</td>
</tr>
<tr>
<td>Fuel value per pound</td>
<td>285.0</td>
<td>365.0</td>
</tr>
</tbody>
</table>

The sour cherry is used principally in pies or in other culinary preparations with sugar added.

Difficulties

The most serious difficulty in the packing of sour cherries has been the presence of worms, but fortunately such infested fruits are lighter than the normal so float and can be skimmed from the surface of the water at the top of a tank. The cherries must be introduced slowly and in small quantity, and the skimming done promptly for after a very short time the cherries sink. This method of separation was developed by the Bureau of Chemistry and all the details published, so there is no longer excuse for not eliminating the infested fruit.

By-products

The matter of the utilization of cherry by-products has not been investigated recently, but the following taken from a Department of Agriculture publication of 1916 is at least suggestive. It is from Professional Paper No. 350, "The Utilization of Cherry By-products," by Frank Rabak:

"Fixed Oil from Cherry Pits: The kernel of the pit, as long known, contains a considerable quantity of oil. Investigations recently conducted show that oily constituents of the kernel can be converted into fixed oil much like almond oil, and a volatile oil practically identical with oil of bitter almonds. The residue after these oils are extracted shows on analysis ingredients that may make it a practical cattle feed similar to linseed cake.

"The fixed oil is the most important by-product of cherry pits. It has a golden yellow color and a pleasant nut-like taste and odor. In character, it is so closely related to imported almond oil that it is believed to possess similar possibilities in the commercial manufacture of drugs, oils and soaps.

"If the pits of all domestic cherries now thrown away at canneries and the pits extracted from imported cherries were processed in this way, it is estimated that they would yield 320,000 pounds of fixed oil worth in the neighborhood of 20c a pound. The best quality of this fixed oil is extracted from the kernels in hydraulic presses. The shells of the pits are first cracked in a mill and the uncrushed kernels separated with sieves. The oil is then pressed from the meats. In a laboratory experiment, the kernels yielded 21 per cent of fixed oil under a pressure of 2,750 pounds to the
square inch. On a commercial scale, however, with presses equipped for heating the kernels under pressure, it is believed that 30 per cent or more can be obtained. The oil can be obtained also by grinding the pits and extracting by means of solvents.

"Volatile Oil: The volatile oil, the second product, remains in the pressed cake after the fixed oil has been extracted by pressure or by solvents. The volatile oil is then secured by chemical means and distillation. In the experiments the oil was obtained at the rate of nearly one pound for every 100 pounds of residue treated. It is estimated that 6,000 pounds of this volatile oil could be obtained if all the cherry pits handled at canneries could be used.

"The value of this by-product, based on the current prices for the very similar imported bitter almond oil, would be in the neighborhood of $54,000.

"The press cake left after both fixed and volatile oils have been removed is believed to contain substances which may make it a desirable stock food. Its most important constituents, as shown by analysis, are fat, protein, including nitrogen compounds, and sugar, and other carbohydrates. The protein amounts to 30 per cent, and in this the cake compares favorably with other stock foods. If cherry kernel meal proves in practice to be as good for feed as the laboratory analysis would indicate, the annual value of this product would be about $12,000.

"Jelly, sirup, and alcohol from juice: The 105,000 gallons of cherry juice wasted each year in the canneries, the experiments show, would, if collected and treated, produce 85,000 gallons of desirable jelly or a large quantity of table sirup, or could be made to ferment and produce alcohol. In the experiments, a cherry jelly, bright red in color and with a fruity odor, was made by concentrating the cherry juice with cane sugar in a vacuum. A small amount of gelatine was then added and the mixture allowed to cool. Other processes in which the concentrated juice is heated with pectin or fruits rich in pectin, the investigators believe might produce even better results.

"The juice also could be made into some 21,000 gallons of an agreeably flavored table sirup by neutralizing the acid in the filtered juice with milk of lime and concentrating it by evaporation and then settling or filtering out the lime compounds.

"The cherry juice, if fermented by the addition of yeast and then distilled, can be made to yield 36 per cent absolute alcohol, or about 5,000 gallons."

Sweet Cherries

The sweet cherry has attained commercial importance only on the West Coast, and there it is confined to certain valleys. The tree is more conical, denser, with larger and heavier foliage than the sour variety. The fruit is also subject to fungus and insect attack.

The principal varieties are Royal Anne, a large light colored variety with some pink in it; the Bing, a large light red fruit; and Black Tartarian, a large black type. The Royal Anne is the favorite both in appearance and delicate flavor.
The sweet cherries find a ready market when fresh, but in order to deliver them to the eastern markets, it is necessary that they be picked so green that they have little of the distinctive flavor of the ripe fruit and in its place one that partakes of the pit with an additional rather bitter tang.

Professors Henry Hartman and D. E. Bullis, working upon the changes which take place in ripening sweet cherries, report (Oregon Agr. Exp. Sta. Bul. 247, 1929) that the sugar, acid, and solid contents undergo material changes during the process of ripening. Sugar, solids, and color increase during the ripening and these are closely correlated with maturity. Acidity makes a corresponding decrease. Increase in weight and volume also occur and these are influenced by the season, temperature, and moisture. Cracking results from excess absorption of water either through the root system or the epidermis, and most of the injury of this character occurs just before the fruit reaches its prime. The fruit from the later-season picking invariably yields a higher juice than the early pickings. Sweet cherries canned when fully mature retain more of their weight and volume than those which are picked when immature. As with other canned fruits, the concentration of the added sirup affects the volume and weight of the product after sterilization in the can.

The total pack of canned sweet cherries is now less than the sour; the census for 1931 gives the amount for that year as about 1,406,000 cases.

The purchase specifications are: “All fruit covered by this contract shall be of good color, shape, quality, and in good condition for canning at the state of maturity buyer may require. Free from doubles, worms, scabs, frost rings, hail or rain damage, red streaks in flesh, wind-falls, visible split pits, parasites, fungi, bruises, spray residue, gum, or other imperfections.

“No. 1 Royal Anne Cherries shall not be smaller than 85 to the pound, including stems. No. 2 Royal Anne Cherries shall be from 86 to 120 to the pound including stems.”

Canning Operations

Sweet cherries are picked with the stems attached and brought to the factory in standard lug boxes but only about two-thirds filled. This prevents any settling of the fruit and insures ventilation.

The stemming is done by hand as the type of stemmer used on sour cherries is not well adapted to these, and no other has been developed which effects any material economy over hand labor. Most of the defective fruit is taken out while the stemming is being done so that little inspection is needed on the tables.

Stemming is followed by washing which is usually done under sprays of water and delivery made onto the grader. If there be room between the washer and grader, an inspection is made to take out defective fruit, especially cracks, sun scald, green, and distorted specimens. Some packers rely wholly upon the persons filling the cans to make such separation when the cans are being filled, but the tendency is to slight the work at this point.

Grading for Size

Sweet cherries are graded for size which is done usually on a vibrating type of peach grader, with the regular screens removed and their places
taken by ones of 22, 24, 26, 28, and 32 thirty-seconds of an inch in diameter. Each size of fruit is conveyed to tables for packing one size only, so that there is no opportunity for mixing the fruit or getting it improperly marked. The size becomes the basis for the grade, the largest size being fancy, the next choice, the third standard, the fourth seconds, and the fifth water or pie. The fancy and choice cherries are often packed together as choice. The density of the sirup follows in the same order as the grading, and naturally it is assumed that only the highest grade fruit is used in the fancy and choice grades.

The majority of the sweet cherries are not pitted, as the nut aids in giving a plump appearance and also imparts a pleasing flavor, both desirable qualities as the fruit is used almost exclusively as a dessert. The cherries are pitted for pie stock.

The percentage of fruit in the different sizes of Royal Anne cherries in central California during a period of several years is approximately as follows: Fancy, 20; choice, 50; standard, 20; seconds and water, 5; and pie, 5 per cent.

The cans are filled by hand, checked by weight, and the sirup added by machine. Since the cherries shrink in proportion to the degree of sirup used, some canners blanch the cherries for about 1 to 1½ minutes to soften the skin so as to take up the sugar with less shrinkage and cracking. This practice, while not general, is of less importance now that the fancy grade has been combined with the choice. It gives a higher cut-out in fruit; that is, from one-half to one and one-half ounces more for a No. 2½ can. Nearly the same result in reducing checking of the skin may be obtained with less labor by using a long low exhaust.

The sirups used are 40, 30, 20, and 10 degrees Brix or Balling for Royal Anne cherries, and other white or black sweet cherries used for fancy, choice, standard, and second grades, but water for the pie grade.

Cherries are siruped at about 120 degrees, and it is desirable to give an exhaust of 10 to 12 minutes at 175, not only to eliminate air and gas but to retain a plump appearance. A longer exhaust at 175° F. up to 20 minutes will lessen the tendency to develop “springers.” There is less splitting of the skins when using this lower temperature than when using 210 degrees for 5 minutes; also less toughening and shrinking of the fruit when a sirup of 40 degrees or more is used. The sweet cherry is so low in acidity that an excessively heavy sirup makes it insipidly sweet. The 30 and 20 degree sirups cause little shrinkage and no toughening. The cooking is generally 12 minutes for No. 2½ cans or less, and 20 minutes for No. 10 cans in the agitating cooker. That is more time than is needed for sterilization but it improves the results. The cans are cooled promptly.

Lacquer-lined cans are not so important for the Royal Anne cherries as for other varieties where it is desired to retain the color. The sweet cherries, except “Bing,” do not have the same tendency to pinhole as have the sour cherries, but have a tendency to produce hydrogen springers after standing for several months and particularly if in a warm room. The cherry needs more head space than most fruits—about ¾ inch for black cherries and ¾ inch for the white varieties.

The bulk of sweet cherries are packed in No. 2½, No. 2, and No. 1 cans.
A large amount is also packed in No. 10 cans for use in cafeterias and restaurants, and to be repacked in fruit salad.

The number of persons and stock required for packing 2,000 cases of No. 2½ cans in one day is about as follows: Quantity of fruit required, 34 tons which yield 60 cases to the ton, the waste from stems and defective material from good stock being approximately 11 per cent; number of persons required for stemming, 250; for canning, 40; forewomen for stemmers, 10; and for canners, 4; number of men for handling fruit, cans, and machinery, 35.

Effect of Varying Degrees of Sirup on Cherries, Weight of Cut-out of Fruit and Sirup

Weight of fruit, 540 grams (19 ounces), No. 2½ cans:

Royal Anne:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>845</td>
<td>555</td>
<td>290</td>
<td>10.3</td>
</tr>
<tr>
<td>10</td>
<td>868</td>
<td>493</td>
<td>375</td>
<td>16.9</td>
</tr>
<tr>
<td>20</td>
<td>887</td>
<td>497</td>
<td>390</td>
<td>20.4</td>
</tr>
<tr>
<td>30</td>
<td>913</td>
<td>478</td>
<td>435</td>
<td>25.5</td>
</tr>
<tr>
<td>40</td>
<td>927</td>
<td>448</td>
<td>479</td>
<td>32.0</td>
</tr>
<tr>
<td>50</td>
<td>936</td>
<td>417</td>
<td>519</td>
<td>37.2</td>
</tr>
<tr>
<td>60</td>
<td>957</td>
<td>397</td>
<td>560</td>
<td>40.5</td>
</tr>
</tbody>
</table>

Montmorency cherries, 400 grams (14 ounces) in No. 2 can:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>597</td>
<td>375</td>
<td>222</td>
<td>16.1</td>
</tr>
<tr>
<td>30</td>
<td>620</td>
<td>360</td>
<td>260</td>
<td>20.1</td>
</tr>
<tr>
<td>40</td>
<td>624</td>
<td>359</td>
<td>265</td>
<td>23.7</td>
</tr>
<tr>
<td>50</td>
<td>632</td>
<td>344</td>
<td>288</td>
<td>28.2</td>
</tr>
</tbody>
</table>

Montmorency cherries, No. 2½: Average ounces syrup per can, 11.9.

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>600</td>
<td>360</td>
<td>240</td>
<td>9.0</td>
</tr>
<tr>
<td>10</td>
<td>612</td>
<td>351</td>
<td>251</td>
<td>12.9</td>
</tr>
<tr>
<td>20</td>
<td>621</td>
<td>357</td>
<td>264</td>
<td>17.7</td>
</tr>
<tr>
<td>30</td>
<td>642</td>
<td>338</td>
<td>304</td>
<td>21.9</td>
</tr>
<tr>
<td>40</td>
<td>631</td>
<td>315</td>
<td>316</td>
<td>25.5</td>
</tr>
<tr>
<td>50</td>
<td>643</td>
<td>300</td>
<td>343</td>
<td>29.7</td>
</tr>
</tbody>
</table>

Average vacuum, 9 inches, ⅜ inch head space.

Standards (California)

Royal Anne Cherries:

Fancy Grade: Fruit to be of very fine quality, ripe, free from blemishes serious for the grade, and uniform in size. Sirup: 40 per cent sugar when packed.

Choice Grade: Fruit to be of fine quality, ripe, free from blemishes serious for the grade and uniform in size. Sirup: 30 per cent sugar when packed.

Standard Grade: Fruit to be of good quality, reasonably free from blemishes serious for the grade, and reasonably uniform in size and degree of ripeness. Sirup: 20 per cent sugar when packed.

Seconds Grade: Trade designation, “Seconds.” Fruit to be tolerably free from blemishes serious for the grade and tolerably uniform in size. In sirup: 10 per cent sugar when packed.
Packed in water: Trade designation, "Water." Fruit to be tolerably free from blemishes serious for the grade, and tolerably uniform in size.


White Cherries—Black Cherries:

Fancy Grade: Fruit to be of very fine quality, ripe, free from blemishes serious for the grade, and uniform in size. Sirup: 40 per cent sugar when packed.

Choice Grade: Fruit to be of fine quality, ripe, free from blemishes serious for the grade, and uniform in size. Sirup: 30 per cent sugar when packed.

Standard Grade: Fruit to be of good quality, reasonably free from blemishes serious for the grade, and reasonably uniform in size and degree of ripeness. Sirup, 20 per cent sugar when packed.

Seconds Grade: Trade designation, "Seconds." Fruit to be tolerably free from blemishes serious for the grade, and tolerably uniform in size. In sirup: 10 per cent sugar when packed.


Maximum Number Cherries Per Can, Various Sizes

Royal Anne:

<table>
<thead>
<tr>
<th>Size</th>
<th>Picnic</th>
<th>Flat</th>
<th>Tall</th>
<th>No. 2</th>
<th>No. 2½</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; 8 oz</td>
<td>31</td>
<td>33</td>
<td>41</td>
<td>51</td>
<td>57</td>
<td>67</td>
</tr>
<tr>
<td>3½&quot; 8 oz</td>
<td>38</td>
<td>41</td>
<td>51</td>
<td>63</td>
<td>71</td>
<td>83</td>
</tr>
<tr>
<td>No. 1</td>
<td>46</td>
<td>50</td>
<td>62</td>
<td>79</td>
<td>89</td>
<td>106</td>
</tr>
</tbody>
</table>

White Cherries—Black Cherries:

<table>
<thead>
<tr>
<th>Size</th>
<th>Picnic</th>
<th>Flat</th>
<th>Tall</th>
<th>No. 2</th>
<th>No. 2½</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; 8 oz</td>
<td>37</td>
<td>40</td>
<td>49</td>
<td>60</td>
<td>67</td>
<td>79</td>
</tr>
<tr>
<td>3½&quot; 8 oz</td>
<td>46</td>
<td>50</td>
<td>61</td>
<td>75</td>
<td>95</td>
<td>107</td>
</tr>
</tbody>
</table>

Maximum Variation in the Number of Cherries Per Can

Royal Anne:

<table>
<thead>
<tr>
<th>Size</th>
<th>Picnic</th>
<th>Flat</th>
<th>Tall</th>
<th>No. 2</th>
<th>No. 2½</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; 8 oz</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>3½&quot; 8 oz</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>No. 1</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

White Cherries—Black Cherries:

<table>
<thead>
<tr>
<th>Size</th>
<th>Picnic</th>
<th>Flat</th>
<th>Tall</th>
<th>No. 2</th>
<th>No. 2½</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; 8 oz</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>3½&quot; 8 oz</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>No. 1</td>
<td>18</td>
<td>18</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>
Label Weights, Unpitted Fruit

Fancy (Sp. Gr. 1.10) : 8Z Short, 8 ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08) : Same as fancy except No. 5, 3 lbs. 10 ozs. and No. 10, 6 lbs. 12 ozs.

Standard (Sp. Gr. 1.06) : 8Z Short, 7½ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Seconds: No. 2½, 1 lb. 12 ozs.

Water (Sp. Gr. 1.04) : No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 12 ozs.; No. 10, 6 lbs. 8 ozs.

S. R. A. 318. Weights of Peas and Unpitted Cherries in Cans of Various Sizes (Cherry Portion)

Properly filled cans of unpitted cherries should yield, at least, the following drained weights, these weights being determined in each instance by draining for 2 minutes on a ½ inch mesh screen:

No. 1 (fruit) : 3 by 4½ inch sanitary.................................10.5 ounces
    Sirup cutting out 20° Brix, or above............................12 ounces
    Sirup cutting out below 20° Brix................................15 ounces

No. 2 : 4½ by 4½ inch sanitary, and 3½ by 4½ inch hole and cap—
    Sirup cutting out 20° Brix, or above............................(18 ounces) 1 pound 2 ounces
    Sirup cutting out below 20° Brix.................................(19 ounces) 1 pound 3 ounces

No. 2½ : 6½ by 7 inch sanitary, and 6½ by 6½ inch hole and cap—
    Sirup cutting out 20° Brix, or above.........................(68 ounces) 4 pounds 4 ounces
    Sirup cutting out below 20° Brix...............................(72 ounces) 4 pounds 8 ounces

Due allowance made in all cases for unavoidable variations in weight.

A can of a size not mentioned here should yield a drained weight of peas or unpitted cherries which bear the same relation to the drained weight indicated for the can nearest in size as that existing between the capacities of the cans in question.

In making declarations under the net weight requirements of the Federal Food and Drugs Act, the total weight of the contents of the can, liquid included, should be declared.

Maraschino Style of Cherry

The Maraschino style of cherry represents an anomaly in manufactured fruit products for in its preparation every vestige of the native qualities of the cherry are sacrificed except its shape; it is shrunken in size; the texture is made tough and leathery; its natural flavor is displaced by one obtained through fermentation and distillation or added by the chemist; the color is made a brilliant red by an aniline or other dye; and even the name is a corruption from the species originally used to produce the added flavor and not that from the kind used for the base. It has little food value other than the sugar which is taken up during manufacture, but it appeals to the eye, which is sufficient reason for its use. One manufacturer designates the product “garnishing cherries” which is more nearly correct.

The preparation of the Maraschino type cherry, that is the white cherry given a true Marasca flavor, is of recent origin as a commercial preparation, its exploitation beginning at the end of the last century. It started in
homes or localities in the Dalmatian mountains, but has grown until it represents a value of several million dollars annually. With this growth has come modification and hastening of the process with a corresponding change in the product. The importation of finished Maraschino type cherries and also of those cured in brine was small prior to 1905, but about that time they became popular as a decoration in cocktails and also for fancy ice cream and ices served at hotels and at parties. The increase in importations made a constant growth and in fifteen years amounted to about 50,000 barrels annually, practically all coming from Italy. As far as can be learned, there was no attempt to cure the domestic product after the Maraschino style until 1912, but from that time onward there has been a constant development in the preparation of the cherry on the West Coast. The packing of fruits for salad provided a new and greatly enlarged outlet for this product.

The evolution of this garniture or confection is difficult to obtain as in its early stage it was made by many persons in a small way without following a definite procedure. The making of a distilled liquor from the small wild dark cherry which grows in the Dalmatian forests, most abundant in Dalmatia Province but also in Italy and France, is old. One type is a sort of brandy, the Kirsch or Kirschwasser of the Germans and the other, the Marasca liquor, a much more elegant and refined Italian product, and it was by combining the latter with cherries cured in sirup that the real Maraschino cherry had its beginning. The making of Maraschino liquor dates from the 17th century, and was in such high favor by the middle of the 18th century that the senate of Venice reserved to itself the right to make sales. By the end of that century, it was imitated in various ways and especially the flavor by the use of Kirsch.

The Marasca cherry has a peculiar, sweet, pleasing odor, and the nuts, a filbert-like flavor. The fresh fruit is of little use, but by bruising the flesh from the pits, partially crushing the latter, and mixing the two with one per cent of white honey, a rapid fermentation takes place. The fermented mass is pressed, filtered, and the filtrate distilled. Other descriptions indicate that the pulp was pressed at once, and the juice thus obtained fermented with the pits, honey, some cherry leaves and bark, and a possible addition of grape wine. When the fermentation was completed, the resulting liquor was distilled and, as in the former case, was set aside for a year when it was again rectified, refined sugar added, and again set aside to age for two years in order to develop its full bouquet and fine qualities which made it one of the most valuable of flavoring liqueurs.

In the preparation of the Maraschino cherry, different varieties of cherries were used at first, but were gradually limited to four or five white kinds, one of them the Napoleon, closely related to the Royal Anne grown in this country. The Italian cherries are of a somewhat firmer texture than ours so they shrink less; they were originally cured in sirup and the liquor added to impart the flavor, and to the latter quality was due their distinction and value. The Italians were very partial to them, but it was not long until the French adopted and modified the methods and introduced sulphur curing. The matter of coloring came later as a development in attractiveness. Different colors were used but the bright red was the one that met popular fancy. The industry changed in that Italy and the mountainous
sections became points for packing and curing the fruit while Marseilles and Bordeaux became the points for its final manufacture.

With the growth and popularity of this confection, there was a corresponding growth in the development of substitutes for the real Maraschino flavor. First, the time was cut in the making of the liquor; then cherry leaves, stems, and bark were used more freely, but as the supply was still insufficient to meet the demand, peach and almond nuts were used, or the oil was expressed for flavoring; as a final step, oil of bitter almonds or benzaldehyde has become the flavoring. The coloring was also greatly improved and instead of Maraschino cherries, the labeling had to be changed to Maraschino style cherries, at least in this country.

As the domestic methods of preparing the cherries were obtained from abroad, and especially that part pertaining to the curing in sulphurous acid, a description of the foreign method with our modifications may be the most appropriate method of presenting it.

The white cherries are picked when hard ripe, before the fruit shows indication of softening, with the stems left attached. They are brought to the factory or brining station and spread on slat trays not more than three inches in depth, or in small plants the cherries may be left in shallow baskets. Defective fruit are taken out at this time, the fruit sprayed very lightly with water to make them moist but not wet. They are then stacked loosely in tiers in a tight room. The room is closed and the fumes of burning sulphur directed therein for about twelve hours. The effect of the burning sulphur is to produce sulphur-dioxide, a gas which combines with the moisture to form sulphurous acid which has a destructive effect upon bacteria, yeast, and molds, kills the cherry tissues, and also acts as a bleach. The next day the cherries are transferred to barrels, headed, and covered with water containing sulphurous acid in solution. Since the acid is antiseptic in the proportion of one part to 700 parts and a barrel of cherries partially sulphured with its brine weighs 385 pounds, it is customary to add about one tenth of one per cent of the acid. A strong solution is used and the amount of the addition is calculated. The barrel is rolled a little each day for four or five days so that all air will arise and come to the bung and its place be taken by additional solution so that the cherries are completely covered. Any cherries exposed in an air space would discolor and soften to some extent. If the cherries be intended for export to this country, about 2 per cent of salt is added to the solution so that the cherries may be technically classified as in brine, which is for tariff purposes only since the salt serves no other useful end. Dark colored cherries are not used for the reason that they will not bleach evenly nor completely.

Formerly all cherries sent to this country had their stems left on, and the barrels held about 220 pounds, but about 1926 or 1927, it was found that by stemming and pitting abroad a material saving could be made in cooperage and freight. The loss on stems and pits amounts to about 20 per cent, and upon imperfect fruit and that split in pitting to from 12 to 15 per cent additional so that by having this part of the work done abroad, there was a material saving in transportation. Moreover, the scarring of fruit from rubbing on the stems while in transit is also eliminated. It requires about ninety days for the hardening and bleaching of the cherries after which they will keep a couple of years or more if held in a reasonably cool place.
Domestic Preparation

The domestic preparation of the Maraschino type follows the same principles as used abroad, but with such modifications as experience and research have found to be advantageous. The principal research work has been done at the Oregon and California Agricultural Experiment Stations since 1928.

The Royal Anne cherry is used almost exclusively, it is picked when just showing pink with stems on, and handled in lug boxes, preferably in layers not more than four inches in depth. If the fruit be damp or plumped because of recent rains, it has been found advantageous to hold it in the lugs over night or long enough to toughen the surface slightly. Fewer fruits will split or crack after such treatment.

The cherries are turned onto an inspection belt where deformed, split, scratched, or sunburned fruit, and leaves are picked out. The fruit with the stems attached are packed 240 pounds in a 50 gallon barrel, headed, and covered at once with a 0.5 to 1.5 per cent sulphurous acid solution, preferably with the weaker solution, and then stored in a cool place. The barrels are rolled and refilled for a few days. The liquid is prepared by discharging the gas from drums into water until the desired saturation is reached, which is checked by testing the acidity. This is much less expensive than transporting the liquid or making it from other chemicals. Prof. Wiegand of the Oregon Agricultural Experiment Station gives the following method for making a sulphur dioxide solution from sodium sulphite for covering the cherries. Water, 100 gallons, brought to a boil, and 25 pounds of sodium sulphite added, allowed to cool, and 6 quarts of sulphuric acid added. As this solution is too strong, it is usual to dilute it 25 per cent, which brings the percentage of sulphur dioxide to about one-half per cent, which in turn is diluted by the cherries so that finally it amounts to practically 0.2 per cent or very close to that used abroad. The sulphur dioxide enters the cherries by osmosis, and it takes about two weeks to establish an equilibrium between the solution and the fruit. The cherries will keep in this solution for a year or more. Under some conditions, as when the fruit is slightly soft or the storage be at air temperature, it is advantageous to add a hardener to the preservative solution. Calcium carbonate or precipitated lime has been found best for this purpose. This is added at the rate of 5 pounds per hundred gallons when the sulphur dioxide is used at the rate of one per cent, and at the rate of 7½ pounds when a higher strength is used. Other materials were tried, but this proved best. When a hardener is used the barrels need to be rolled twice a day for at least a week. This is to insure that the hardener does not settle until the object has been accomplished.

At the factory, the barrel is drained and the cherries washed thoroughly with cold water, the water being changed twice each day. A better way is to introduce a hose into the bottom of the barrel and allow a small stream of water to pass through and overflow. The minimum time required to eliminate the acid is about 5 days, and it is not safe to figure under one week. The work can be hastened by warming the water to 90 to 95 degrees once each day, this followed in about one hour with cold water. Warm water hastens the withdrawal of the sulphur dioxide, but also causes softening so that it needs to be used with caution. The percentage of sulphur dioxide...
must be reduced to less than 0.033 per cent to comply with the requirements of the Department of Agriculture. This is not at all difficult to meet, but necessitates that tests be made so as not to depend upon the judgment of the superintendent. Cruess and Nouty determined the rate of loss of sulphur dioxide in experimental lots, using the leaching method. They found that cherries containing 680 milligrams of the acid per kilo at the beginning were free at the end of 12 hours.

When the cherries are sufficiently washed, they are stemmed and run over graders to obtain certain sizes.

They are next pitted, and this operation, like the stemming, is a hand operation as the value of the cherry depends upon its appearance, and as yet no mechanical device has been invented which equals hand labor for this work. The pitting is done with a small, narrow spoon that is thrust into the stem end alongside the pit, and in withdrawing it the pit is drawn out through the same opening. Formerly, a wooden handle into which five needles or fine wires were inserted, arranged in a star shape, were thrust into the cherry to push the pit out through the stem opening. That method left a small opening at the top so has been displaced by the spoon.

After pitting, the cherries are blanched for from 6 to 8 minutes with water at about 175 degrees in order to remove as nearly as possible all the sulphur dioxide, for after the pit is removed the water comes in contact with the deeper tissues not so easily reached in the soaking. This step makes it possible to reduce the sulphur dioxide to less than one-tenth that which is permissible. The cherries are thoroughly chilled after the blanching.

The cherries are now ready for coloring and impregnating with sirup, an operation which can best be conducted in glass-lined kettles, but in lieu of which clean barrels may be used. The fruit and a 20 degree sirup are placed in a tank or barrel in the proportion of ten pounds of the former to one gallon of the latter. The sirup is added hot, at about 175° F., but not at boiling. When working with barrels, it will be found that 150 pounds of cherries and 15 gallons of sirup will be a convenient batch to handle. After the cherries and sirup have been together for about an hour so that the sirup has become distributed to them evenly the sirup is drawn off and a permissible color added to it, which in this case is Ponceau 3 R. The stock color is first made by dissolving one-half pound of Ponceau 3 R in one gallon of hot water, and this is bottled as it is sufficient for a number of batches. Nine ounces of this stock is sufficient to color 150 pounds of fruit and 15 gallons of sirup. If a very strong color be wanted, an additional half ounce or more of stock may be used, which is added to the drawn off sirup, reheated to the same degree as before and added to the cherries, then gently but thoroughly stirred. It might seem more logical to add the colored sirup from the beginning, but experience seems to indicate that greater uniformity in coloring results by following the procedure of adding the plain sirup first. The sirup is drawn off each day for four days, reenforced with 25 pounds of sugar, and on the fifth day it is built up to test 45 degrees. Another way, and one preferred by most preservers, is to heat the contents of the barrel with a movable copper coil, as the entire contents may then be heated to 165° F. In that case only about three gallons of sirup are drawn off to receive the reenforcement of the sugar.
The principal object in the heating is to prevent any fermentation, and the heating of the sirup alone is too near the borderline to be safe under all circumstances. Impregnation of the tissues is also aided as the sirup must be built up slowly, otherwise the fruit shrinks unduly. Formerly cochineal was used as a color, and still is in some places where coal tar dyes are barred. Erythrosine is also used, and is the dye preferred in Europe.

A large volume of the Maraschino cherries are used in fruit salads, and for that purpose the dye must be fixed, that is, must not bleed or become diffused into other fruits. In order to secure this end, it is necessary that acid be added in the final step in dyeing and siruping, and 0.25 per cent of citric acid is best suited for this purpose. The same thing is done by using sulphurous acid in very small amounts, and is recommended by some persons but that seems illogical especially as it may run counter to some of the state food laws. Those who follow that method depend upon the fact that the cherries are only a small proportion of a fruit salad, and that the dilution will be such as to keep well within the legal limits.

After the final treatment, the cherries are drained, the surplus colored sirup washed off, and they are ready for packing in plain sirup containing the imitation Maraschino flavor. There are many formulae for the artificial flavor, and various mixtures are offered by the larger extract manufacturers. The basis of these is the alcoholic extract of oil of bitter almonds with a sufficient amount of other flavors to form an agreeable blend. Erich Walter in his “Manual for the Essence Industry,” gives the following:

“Essence for Artificial Maraschino (1 ounce per gallon) : Oil of rose, $\frac{1}{2}$ dram; oil of cinnamon, 1 dram; oil of Neroli, 1 dram; ethyl acetate, 2$\frac{1}{4}$ ounces; ethyl nitrite, 5 ounces; raspberry distillate, 1$\frac{1}{4}$ pound; wine brandy, 1$\frac{1}{4}$ pound; bitter almond water, 2 pounds; colorless cherry flavor, 2 pounds; alcohol, 3 pounds. Total, 10 pounds.”

The foregoing would suffice for flavoring 160 gallons.

The large bulk of western packed fruit is put up in No. 10 lacquer-lined cans to be used in fruit salad. The fruit is covered with sirup, exhausted 10 minutes at 200°, and cooked for 30 minutes at boiling, and cooled.

The cherries are also packed in 3, 5, 7, 15, and 30 ounce jars for use in small quantities. The cook is held to about 185° for 40 minutes for jars of 8 ounces or less, and for 50 minutes for 16 ounces, and 60 minutes for 30 ounces.

Broken and minced cherries are sold in quart and half-gallon jars to bakers and for use in ice cream.

**FIGS**

*Ficus carica*

Those who take Bible lore literally and believe the apple to be the most ancient known fruit naturally attribute an equally ancient origin to the fig. The very modern economic botanist, who while neither affirming nor denying the ancient account, gives assurance that the native home of the fig, like that of the almond, apricot, prune, olive, date, and table grape is in western Asia in the region where the beginnings of man are supposed
to have taken place. The fruit is referred to frequently in the Arabic and Armenian languages and in Hebrew history in a manner indicating the high esteem in which it was held. Some students hold that it is the oldest cultivated fruit. A distinction is clearly drawn between the wild and cultivated sorts by more modern and lesser authorities, such as Homer, Theophrastus, and Dioscorides who wrote more than 2,000 years ago. It has been and still is a highly economical crop in Turkey, Greece, and other countries bordering on the Mediterranean. Its range of cultivation in new territory was greatly extended by the Romans while in their ascendency. It has been regularly imported into England from Spain since 1250. It was brought to this country by the Spaniards when constructing the Fort at St. Augustine, Florida, and was subsequently distributed along the Gulf Coast as far west as New Orleans and also carried to Mexico. From this latter country the Padres carried it to Lower California and California when they established their missions in the eighteenth century. Trees from these early plantings were still bearing at some places when the gold rush occurred in 1849. Naturally a fruit held in such high regard for so long a time was imported from various other sources and tried in different parts of the country.

The fig tree is adapted to the warm parts of the temperate zone. It is rather coarse and is the largest growing fruit tree, individuals have been known to grow to a height of fifty to sixty feet with a spread equally wide though these are exceptional. Under favorable conditions a height of twenty feet is attained with a corresponding spread but by severe pruning is usually kept to a much smaller size. The branches are irregular and stiff and openly spread, with bark of a light gray in color. The leaves are generally large and three- or five-parted. The flowers are not exposed as ordinarily, the fruit representing one of the queer developments in the higher form of plants. The fruit starts as a bud at the axil of the leaf and develops in a globular or pear shape. When about one-half grown, the flowers form on the inside of the closed bud. In some varieties both male and female elements are present and seeds are formed. In other varieties fertilization is necessary from outside, in which event the pollen must be carried by an insect capable of making its way into the bud at the outer end. This is true for the Smyrna or Calimyrna fig with the Capri fig as a source of pollen. In still other varieties the fruit develops with abortive seeds, a condition represented in the Kadota. Fruits vary in size from less than three-fourths of an inch to three inches in diameter and the color from a light straw yellow through dark yellow with some green, purple, bluish, reddish, and brown. The tissue surrounding the pulp, the pulp, and seeds are rich in sugar so that it cures on the tree or in trays if picked and this quality with its agreeable distinctive flavor gives it its value. Some strains have been developed so that they are tender, delicate, and fine for use when fresh while others are better after curing.

The tree withstands moderate freezing if given light protection and can be grown as far north as Virginia but does not bear well except in the South and near the Southwestern coast. In orchards it is planted in rows about twenty-five or thirty feet apart and the same distance apart in the row. Some of the smaller varieties are planted more closely and trimmed back to keep them low so as to favor picking the fruit. They need a heavy
soil and plenty of water. Propagation is by cuttings which develop readily so that trees begin to bear about the fourth year but not profitably under six years and seldom come to full bearing under twelve years. The yield is from 1.5 to 4 tons per acre but with a rather high cost on account of the labor involved.

While the fig has been grown as a household fruit and on a small commercial scale for many years, it has only assumed importance as a canning crop since 1920. About that time there was a large increase in the planting of trees and as a consequence, a market for the product was necessary.

The Celeste is the variety most grown in Louisiana, Mississippi, and the southeastern states. It is small, averaging hardly an inch in diameter, thin skinned, with greenish to purple color, very tender, with a delicate yet characteristic flavor, and conceded to be one of the best figs to be used fresh. Care equal to that for the strawberry is its chief handicap in shipping and manufacture. Locally it is used for preserves and for canning but not in large commercial operations.

The Magnolia fig, which is of the Brunswick type, is the one raised in Texas. It is larger than the Celeste, of a darker color with a tinge of brown, is tender but the skin has a thin corky layer which needs to be removed, and is preserved and canned rather than dried. These methods of handling were started on a commercial scale in 1902 and gradually increased but with little competition until 1924. Since that date the western fig has become a contender in the same field. The development of the industry in Texas and making the product known nationally are due principally to J. C. Carpenter.

The Kadota and Calimyrna are the leading varieties of figs for preserving and canning on the West Coast. The former is of Italian origin brought to this country about the middle of the last century but recently rechristened. The fruit is small to medium in size, in shape more nearly globular than most other varieties, has a light lemon color with greenish veins, with fairly firm flesh but inclined to be tough, the pulp a light amber and the seeds small or abortive so that it is considered nearly seedless. It is sweet but deficient in the distinctive fig flavor. However, this quality is developed to some extent in the cooking, which is the reverse of what happens with most fruits. This variety is used more for making preserves than for canning.

The Calimyrna fig is the Smyrna fig with a new name made necessary to comply with the pure food law. A Smyrna fig would indicate the geographical point of production and particularly when the country is the chief point of production. It was introduced into this country many years ago but without the accompanying Capri fig and insect to fertilize it and so remained unproductive, requiring years of work, until the nineties, to complete the importation. A prior accidental importation of the insect had taken place and became established in one locality but that fact was not known until after the introduction of the insect had been accomplished. The Calimyrna fig has the advantage of being the best drying fig grown in this country and by some is regarded also as the best variety for canning. It is medium in size, light in color, fairly tender, thin skinned, with plenty of flesh and pulp, and with strong flavored small seeds.
Use

While the fig has been used for centuries where grown, both fresh and dried, as an important article in the diet, in other places it is used extensively in cakes, pastries, and confections because of its flavor and agreeable character, though so luscious that a small quantity suffices to satisfy either appetite or hunger. It does not follow that it will have the same appeal when canned, as it lacks the acidity and tang, characteristics of the fruits which are popular. The fig preserve is so sweet that it cloys, so is eaten only at infrequent intervals.

Composition

The composition of the fig as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Ash</td>
</tr>
<tr>
<td>Carbohydrates</td>
</tr>
<tr>
<td>Fiber</td>
</tr>
<tr>
<td>Sugar</td>
</tr>
<tr>
<td>Fuel value per 100 grams</td>
</tr>
<tr>
<td>Fuel value per pound</td>
</tr>
</tbody>
</table>

Development of Canning

The packing of figs began as a preserve both in the home and in commercial establishments and canning followed as a development from that product, differing chiefly in the reduction of the strength of sirup and the amount of cooking. Some commercial preserving of the figs was done at New Orleans for a long time, in Texas since 1902, and probably on the West Coast for about the same length of time. The Texas fig became the better known because it was of especially good quality and well advertised. Canning is about equally old as an accompaniment of preserve and jam making but it is only since 1920 that an attempt has been made to make it a commercial proposition on the same basis as other fruits. It has not yet acquired a status to comply with definite specifications nor is it given place in statistics. The equipment, too, is undergoing development. The fig has peculiarities which prevent it from being handled in the same manner as other fruits and the variations necessary to get a good product on a volume basis have not been determined in detail. For these reasons a deviation will be made for the usual presentation of the subject, the preserve will be considered first and following that the steps leading to the canned product.

The Celeste Fig

It is necessary to pick the Celeste fig when ripe but not too soft, a period that allows only a narrow leeway for handling in the orchard. The flavor is deficient and even somewhat disagreeable when the fruit is green, and further, it ceases development when once off the tree. If the fruit be too ripe, it is difficult to handle and breaks down in cooking. The picking is, therefore, of first importance, necessitating that the tree be gone over at least once every other day. The figs are placed in small boxes, shallow baskets, or trays, and as it is nearly as tender as the strawberry, it mashes
or molds just as easily. The fig is given a slight twist in taking it off the branch so as to have the stem attached. If the stem be pulled out, souring or molding follows promptly. The packing must be done the same day as the picking or on the next following.

The fruit is washed under sprays and as it passes along on the inspection belt, is sorted into three grades according to size and condition. The first grade consists of large perfect fruit, the second of smaller fruit that is practically perfect, and the third of small, irregular fruit and that which is soft or slightly broken. This work is most often done by hand though recently tube graders have been introduced as an aid in sizing. The first grade is usually stemmed or the stem cut short, the second may or may not be stemmed.

The fruit is washed under sprays and as it passes along on the inspection belt, is sorted into three grades according to size and condition. The first grade consists of large perfect fruit, the second of smaller fruit that is practically perfect, and the third of small, irregular fruit and that which is soft or slightly broken. This work is most often done by hand though recently tube graders have been introduced as an aid in sizing. The first grade is usually stemmed or the stem cut short, the second may or may not be stemmed.

The preserves are most often made in small batches of about 40 pounds or less and in two or three steps. The figs are first placed in a 30 to 35 degree sirup and heated, but not boiled, for a half hour or more after which they stand for an hour or two for the purpose of having them take up some sugar and get rid of gases in the tissues. This virtually serves as a blanching process. The sirup is then drawn off, concentrated, and sugar added to make 55 degrees, and again returned to the fruit, the cooking and cooling being repeated. If the factory be short on pans or space, the figs are now placed in jars, the sirup again concentrated and sugar again added to bring it to about 70 degrees while hot and it is poured on the figs in the jars. If there be plenty of room and equipment, the figs may be held in the sirup over night and the final preparation done on the second day. The latter treatment permits more time for the osmosis of the sugar resulting in a more translucent plump product. After the 70 degree sirup is poured on the figs, they are exhausted and sterilized which is easily accomplished owing to the heavy sirup. Twenty minutes in boiling water is sufficient if the jar be hot as it comes from the exhaust box, otherwise an increase in time is necessary. It is obvious that such a method is slow and requires much labor. The filling of the jars is hand work and unless care be taken, more or less fruit is broken.

The second grade of whole fruit is given a blanch of about three minutes in hot water, the fruit placed in jars and a 60 degree sirup added, heated in a water-bath at 180° F. for an hour and a half, then sealed, and cooked for 20 minutes. The long heating is necessary to get a translucent product but causes sufficient shrinkage to require some adjustment of solids before closing the jar. It reduces time and labor over the old method but the sirup does not test as high in the final product. The jars are not cooled in order that the effect of the heat may be prolonged.

The small broken, and soft fruit are forced through a coarse screen, sugar added, and kettle cooked for jam.

Figs packed in the manner indicated are usually put in glass, the preferable sizes being 5, 8, and 16 ounces. A very simple equipment serves for the work.

When packed in tin, figs of this variety are blanched about three minutes, care being taken that they do not become too soft to be handled without breaking, filled into cans, a 45 degree sirup added, and exhausted for a long time. Most packers fill the exhaust box and allow it to stand 20 minutes or
more, then close and sterilize the cans, but do not cool after cooking. The 8Z and No. 1 cans are preferred.

The French use a fig which is similar to the Celeste and make the following variations which possibly might be found advantageous here. The blanching is done in batches starting with warm but not hot water. Ten minutes or more are taken in raising the water to near the boiling point and then the temperature is maintained for 10 minutes. By starting with a comparatively low temperature the skin is not burst as it is when the fruit is dropped into hot water. The same procedure is used in adding the sugar. For preserves, equal weights of sugar and fruit are used and heated very slowly and gently until they come to a boil. In canning, a 50 degree sirup is used but added cool and slowly heated. The slow treatment in both cases is to improve the appearance. Their cooking or sterilizing is essentially the same as in this country.

Texas Canning and Preserving Methods

As previously stated the Magnolia fig was first packed in Texas by J. C. Carpenter. He started the preserve or heavy sirup style of packing and others have followed.

The Magnolia fig matures in the eastern section of Texas from the middle of July until October, a fairly long season for packing. Like the Celeste, it needs to be picked every day or every other day to have perfect maturity on the tree, otherwise it lacks quality. The picking is done from the ground or by means of short ladders and is rather tedious so that the average picker gathers only about 400 pounds per day. The fruit is given a slight twist so as to include the stem. Transporting the fruit from the orchard is done in lug boxes holding from 30 to 35 pounds which seems rather large considering the character of the fruit. Delivery is made promptly so that preparation may take place the same day or the next following. Cold storage facilities are now provided for that which is carried over night or even for a few hours.

Fruit is graded for size, usually into two, three, or four, and while this was formerly done by hand, it is now done by spreading rubber tube graders. Standards have not been adopted either as regards measurement or count per pound but each packer follows what he considers best suited for his trade. The grading may be done directly from the boxes as a preliminary operation or after the peeling, the former being more convenient but the latter yielding somewhat more uniform results.

The Magnolia fig has a thin but rather hard corky layer on the skin which is best removed by lye peeling. This can be done easily by dropping the fruit into a 2 per cent solution of hot lye for from 10 to 15 seconds and spraying at once or washing in a stream of running water. The figs must be handled so gently that special apparatus, consisting of a tank and conveyor, have been built for the purpose. The regular spray lye peeler used for peaches is satisfactory but has too large capacity except for the largest plants. The lye peeling also eliminates the color and the fig acquires a clear translucent appearance in the finished product. The term skinless has been misapplied to such peeled fruit.

The figs are inspected as they pass over the belt and any with defects such as corky spots, splits, or discoloration are removed. The stems on
large fruit are generally clipped off or trimmed to about three-eighths of an inch. Frequently the base of the fig requires a little scraping.

Graded figs for preserves are made into batches by measurement or weight and delivered into jacketed kettles holding from 175 to 200 gallons. These kettles were formerly made of copper but lately the shift is toward aluminum and stainless steel. A batch consists of about 700 pounds of fruit and 500 pounds of sugar with only sufficient water to start the sugar to dissolve. The fruit and sirup are heated slowly until the mass reaches about 185° F., held at that temperature for one to two hours, then allowed to cool in the kettle which takes an equally long time or longer. This frees the fig of gas, some sugar is taken up, and a clear translucent appearance is acquired. The slow heating avoids breaking the skin and the fruit remains much plumper than when the heating is rushed. The figs are dipped from the kettle by means of a large perforated ladle and deposited in shallow pans to be delivered to the fillers. These may be carried to the filling tables on special trucks or placed on conveyor belts or a merry-go-round type of table to be distributed. The filling is done directly from the pans into the jars and the layering done by paddles or spoons. The placing of the fruit adds much to the appearance and also to the cost. In the meantime the sirup is boiled or reenforced to from 70 to 75 degrees and used to fill the jars. This is added hot and, since the fruit had a sufficient preliminary cooking, is sealed and sterilized at once. The cooking is 30 minutes for pints in glass and half that time in tin. The method differs from the former in that large batches are used, which saves in labor and cooking space but the tendency is to break more fruit. It is intermediate between the quick process of heating to 220° F. in a heavy sirup and the slow process of heating three or four times in as many days.

Ungraded fruit is generally handled in the same manner as the graded but given a lighter sirup.

Kettle-run figs are ungraded and in addition contain broken fruit. These are cooked in the kettle as in the previous case but in a light sirup. The main purpose of the kettle cooking is to get translucency. The figs are delivered to a hand filling machine and after filling into the cans are covered with a 40 degree sirup. The product is used by restaurants and hotels and packed in Nos. 1, 2, and 10 cans. Since neither the cooking nor holding in the kettle is as long and the filling requires less than one-tenth the labor, it effects a considerable economy in packing.

Broken, small, and irregular figs are run through a coarse screen or pulping machine and reduced to a pulp or made into jam.

California Fig Packing

The packing of figs in California received an impetus as a result of the land boom following the war. Large acreage was set to figs and when the trees came into bearing, some means for handling the crop other than by drying became necessary. In the years since 1920, methods and equipment have been devised for the economical handling of the fruit in preserving and in canning, the belief being that the canned fig might enjoy a popularity similar to the peach. The public, however, has not shown enthusiasm.

The Kadota fig has received most attention since it has good appearance, light color, thin skin, small seeds, and is not easily broken in handling. The first crop which comes from the old wood the latter part of June and
July is not desirable for canning and instead is dried. The later crops extend from August until November so that the season is a long one. Harvesting has to be done three times each week in order to get the fruit at the proper stage of maturity. A unique appliance for harvesting is the development of a knife blade which is attached to the thumb to cut the fig from the tree instead of pulling it; it is claimed that less injury results from this method. The fruit is collected in shallow trays not more than three layers deep. The first operation at the factory is to hand sort on an inspection belt in order to remove all caprified figs and others which show spots or blemishes. Caprified fruit is tough and woody, unsuitable for preserving or canning, and results from planting near orchards of other varieties.

Sorting for size is done by running over a rubber tube grader.

The majority of the packers consider the skin so thin that removal is unnecessary and further prefer that it remain as a protection in subsequent operations. Where the opposite view is held, lye peeling is used. One firm punctures the fig by means of needles as a preliminary operation in a manner similar to the treatment formerly given to the prune, or in the preparation of the fruit for household use. Puncturing with needles has long been followed by the French as a routine practice. After the lye peeling, which lasts from 10 to 15 seconds, the fruit is given a short blanch in hot but not boiling water for three minutes to prepare the tissues for the more rapid osmosis of the sirup in subsequent operations. This system of puncturing and lye treatment has been patented, the descriptive portion of which is quoted at the end of this chapter.

The figs for preserving are kept in small batches, not more than 20 pounds, sugar of equal weight added, and then cooked in small preserving kettles until the fruit is translucent or has a slightly brownish color. The time in the kettles varies considerably, some packers cooking fast and hot while others conduct the work more slowly. The quick cooking saves time but toughens the skin. The slow cooking effects better appearance and flavor. The contents of the preserve kettle are turned into a pan and allowed to stand and cool. A special preserving kettle has been devised with removable inner shell so that different holders can be used on the same outer shell. The inner shells take the place of the pan. The time the fruit is allowed to stand depends in a measure upon the capacity of the plant and the urgency of the work. It may be as short as four hours or remain until the following day. While standing, the sugar is taken up by the tissues and less shrinkage occurs than if dependence be placed upon the entire process taking place in the sealed jar. The jars are filled and the sirup concentrated or reinforced to about 70 degrees, added hot, and then the jars sterilized. Nos. 10 and 2½ cans are also used. The cooking is continued until the fruit shows the proper tenderness or about two hours at boiling or 30 to 40 minutes at 225° F. The higher temperature gives a slight darkening of color.

Another system of cooking has been developed by N. E. Beckwith. A series of electric heating units are arranged in a row on a table. A conveyor is so placed that aluminum boxes are built to hold 30 pounds of figs and sufficient water or weak sirup to cover the fruit. The boxes are set on the conveyor and carried slowly over the heaters where the figs are brought quickly to boiling and held near that temperature during the balance of the trip. The sugar is added to make the desired degree of sirup after about
15 minutes and is cooked into the fig. There are 46 heating elements in
the line and the conveyor is timed to take an hour to pass over them. The
conveyors carry the boxes past the heaters and as they pass, the figs are
lifted out with ladles and deposited in the jars so there is little delay in
that step. The sirup is poured into a kettle, concentrated, if necessary more
sugar added, and is then filled into the jars or cans by machine. The cook-
ing is essentially the same as in the former case or until the fig is tender
and has the desired appearance.

A further modification in the canning of the Kadota fig is to fill the
cans with graded and washed figs, add water, and then run them through an
exhaust box from 10 to 12 minutes which serves as a blanching, then drain,
sirup, and cook as before. In this scheme the can becomes the unit instead
of the small kettle or box in the semi-automatic machine.

A patent has been granted for a device for handling a number of cans
together as a unit. The cans are filled with figs, placed in a frame with a
screen over the top, the frame with the cans on their sides is conveyed first
through a tank of water for blanching, drained, and then carried through
a siruping tank in the same way as a pre-cook in sirup, drained, filled with
a hot heavy sirup, sealed, and given the final cooking. From the sanitary
standpoint, the device ranks with the old dip tank.

W. V. Cruess reports some experimental work in canning in which the
best results were obtained by Blanching the figs, then filling into cans, cov-
ering with a 25 degree sirup, running through an exhaust box in 30 min-
utes, allowing the cans to stand for an hour, draining, resiruping with 55
degrees sirup, exhausting, and cooking in an open bath for one hour. The
figs so treated were translucent, plump, and of good flavor. He also re-
ported upon packing without blanching, the effect of which was to heighten
flavor but resulted in poor appearance.

The canning of the Calimyrna fig is somewhat simpler. The Fig and
Peach Growers’ Association evolved the following method: The graded
figs are blanched, cooled, and conveyed to filling tables. The figs are then
packed in jars or cans and covered with a 60 degree sirup, exhausted, then
cooked in an open vat for 2½ hours to produce the proper consistence.
The fruit can be sterilized in 15 minutes, but the additional time is needed
to produce the desired appearance and tenderness. A 60 degree sirup gives
a cut-out of 38 to 40 degrees.

Experience has indicated that the use of the agitating cooker causes
breakage of the fruit. The continuous pressure cooker of the non-agitating
type can be used and get the desired tenderness and color.

The following are the sizes for figs proposed by the Association.

<table>
<thead>
<tr>
<th>Can</th>
<th>Calimyrna Figs</th>
<th>Kadota Figs</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 tall—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>6 to 8</td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>8 to 10</td>
<td></td>
</tr>
<tr>
<td>No. 2½—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jumbo</td>
<td>6 to 8</td>
<td>15 to 20</td>
</tr>
<tr>
<td>Large</td>
<td>8 to 12</td>
<td>25 to 30</td>
</tr>
<tr>
<td>Medium</td>
<td>12 to 15</td>
<td>35 to 40</td>
</tr>
<tr>
<td>Small</td>
<td>15 to 18</td>
<td></td>
</tr>
<tr>
<td>No. 10—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>30 to 40</td>
<td>60 to 70</td>
</tr>
<tr>
<td>Medium</td>
<td>40 to 50</td>
<td>90 to 100</td>
</tr>
<tr>
<td>Small</td>
<td>50 to 60</td>
<td>110 to 140</td>
</tr>
</tbody>
</table>
Label Weights

California Fancy (Sp. Gr. 1.14): 8Z Short, 8½ ozs.; 8Z Tall, 9½ ozs.; Picnic—No. 1 East, 11½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 15 ozs.; No. 10, 7 lbs. 2 ozs.

Choice (Sp. Gr. 1.12): 8Z Short, 8 ozs.; 8Z Tall, 9 ozs.; Picnic—No. 1 East, 11¼ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 15 ozs.; No. 10, 7 lbs.

Standard: No. 2½, 1 lb. 13 ozs.

Water (Sp. Gr. 1.05): 8Z Short, 7¼ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 1 Tall, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 10, 6 lbs. 9 ozs.

Texas (Sp. Gr. 1.16): 8Z Short, 8½ ozs.; 8Z Tall, 9½ ozs.; Picnic—No. 1 East, 11½ ozs.; No. 300, 1 lb.; No. 2, 1 lb. 6 ozs.; No. 2½, 2 lbs.; No. 10, 7 lbs. 4 ozs.

The pack of Kadota figs is from 55 to 60 cases per ton of fruit depending upon the method of preparation. The packaging of Kadota and Calimyrna figs seems to be about as follows: 20 per cent, 8 ounce; 50 per cent, No. 1 Tall; 15 per cent, No. 2½; and 15 per cent, No. 10 cans.

Patents Pertaining to the Preservation of Figs

Patent No. 1,635,471, issued July 12, 1927, to A. T. Gahan, Fresno, California, contains the following:

This invention relates to improvements in the fruit canning industry and particularly to the canning of figs. The figs are placed in syrup in their cans and then cooked somewhat before the cans are sealed. As is well known to those in the industry, however, the figs must be pre-cooked before they are placed in the syrup in order to remove a peculiar flavor otherwise present. Up to the present time, as far as I am aware, the figs have been pre-cooked in bulk lots in large vats or the like from which the figs are then ladled out and placed in the cans for immersion in the syrup for further treatment. This handling of the naturally delicate figs in their cooked and even more delicate and tender condition causes an appreciable percentage of the figs to split and be otherwise damaged and considerable loss is thereby entailed.

The principal object of my invention, therefore, is to eliminate the above objectionable features by arranging for the figs to be pre-cooked after being placed in the cans and for passing the cans automatically and continuously from the pre-cooking tank to the syrup tank, while providing for the positive draining of the water from the cans after they leave the pre-cooking tank and before they enter the syrup tank.

By means of this arrangement any handling of the figs after they are once in a softened condition is avoided and the figs are never touched after they are once placed in the cans in their normal dry condition. Canning operations are, therefore, expedited and losses due to damaging of the figs by handling the same is eliminated.

Patent No. 1,704,367, issued March 5, 1929, to T. C. Moore, Fresno, California, presents the following general statement:

This invention relates primarily to a process of preserving figs, but is equally adaptable to other fruit.

Heretofore, in preserving figs, it has required from sixty-five to seventy-five minutes to thoroughly cook and preserve the figs. Considerable loss has been experienced due to the fruit splitting or bursting during the cooking period thereby resulting in deterioration of the product by shrinkage, loss of color, splitting and attractive appearance.

The object of the present invention is to provide a process of preserving figs in which the time required for cooking is reduced to a minimum; the danger of splitting or bursting eliminated; and the fruit permitted to retain its natural color, thereby producing an attractive and palatable fruit, natural in color and plumpness and at the same time increasing the preserving qualities and reducing the cost of production to a minimum.
I accomplish this object by first perforating the figs with a multiplicity of very small perforations which extend entirely through the fruit, thereby providing free and easy access of a syrup solution to the interior of the fruit and, at the same time, permitting escape of excess heat and steam from the fruit, while cooking, thus avoiding the possibility of the fruit being damaged through bursting or splitting. The perforating of the figs also serves another and important function, to-wit, that of permitting draining off or escape of the milk under the skin which, otherwise, would impart a bitter flavor and would also cause darkening or discoloring of the figs when cooking the same.

In practicing my process, I first take fresh ripe figs and perforate the same in any suitable manner, but preferably by the use of a machine provided by me for that purpose and forming the subject matter of a separate application entitled “Fruit perforating machine,” filed Nov. 1, 1926, Ser. No. 145,677. The fruit is then placed in a lye bath which absorbs the milk and which softens the skin sufficiently to permit it to be freely removed by agitation in boiling water. After the skins have been removed and the figs washed, they are placed in pans of convenient size for handling.

A syrup solution composed of substantially one part corn syrup and two parts cane syrup equal to thirty degrees Brix or Balling, is then poured over the figs until they are covered. The contents of the pans are then subjected to a boiling action from 12 to 15 minutes more or less. The pans are then set aside and the contents permitted to cool: During the cooling operation the figs absorb the syrup solution and thereby causes them to assume their normal plump and natural shape.

The figs are then packed into jars while cold and the syrup in which they were previously boiled is again heated to a temperature of approximately 212° F. and is poured over the figs in the jars until they are covered. The syrup solution is then subjected to a sterilizing operation from 12 to 30 minutes, depending upon the size of the jars.

By using cane syrup and corn syrup in the proportions specified the figs retain their natural flavor and the excessive sweetness obtained by the ordinary process of treating or preserving figs is avoided.

In the use of the ordinary process, by reason of the fact that the figs are not perforated, the syrup cannot permeate entirely through the figs and a syrup of much greater density is, accordingly, required to preserve the same. By perforating the figs, I am enabled to use a much lighter sugar content, because of the fact that the syrup can permeate entirely through the fruit and by reason of this permeation, the fruit can be stored indefinitely until needed and furthermore can be used for other purposes, such as candied fruits, jams, jellies and the like. On the other hand, by using heavy syrup by the ordinary method, the fruit is rendered unsuitable for other purposes and must be packed immediately. A heavy syrup also causes loss of color and plumpness due to the longer cooking period required and the inability of the fruit to absorb a sufficient quantity of the syrup.

FRUITS FOR SALAD

The foregoing is the approved form for designating a mixture of a good grade of fruits packed in an attractive style in syrup. The older designation, fruit salad, is the more nearly correct form if one accepts historical usage as the proper basis for arriving at the terminology. Fruit macedoines or fruit mixtures have been packed abroad, especially in France, for a long time. They are generally put in glass with the different fruits so arranged as to present an attractive appearance and are intended to be used as a dessert or as a salad. The mixture is made to appeal to the eye and to excite the sense of taste. Fruit mixtures have been packed in this country for a long time but were not selected or apportioned with reference to a dessert service and in that condition found little sale. It was not until 1913, when J. C. Ainsley of Campbell, California, began experimenting with different combinations of fruits and in definite proportions to
produce a certain number of helpings from a can, that real progress was made. With the larger fruits such as the peach or pear, cut in halves, a single piece would be apportioned to a service; by cutting the peach into quarters or sixths, and the pear into quarters, two pieces might be used; with apricots, one or two halves; the pineapple, one or two sectors depending upon the cutting; and in addition, two or three white cherries, or one of the Maraschino type. Somewhat similar proportions were followed with other combinations. Success attended this new style of packing, and other canners followed suit making such combinations as they thought best.

Owing to the fact that the several fruits do not ripen at the same time and that canned stock must be used, it is possible to pack at any time and to limit the quantity to immediate demands. The grade of fruit most suitable for the purpose is Choice, and since sugar is used in the original packing, a uniform fill and cut-out are easily obtained.

After fourteen years and the pack grown to more than a million cases annually, it was agreed among canners that one combination of fruits would be better in the trade than many and that from their experience this should be composed of apricots, Bartlett pears, yellow cling peaches, pineapple, and the Maraschino type of cherry; fruits that present a variety of color, are reasonably firm so they do not mash, and the flavors blend in an agreeable manner. The present specifications are as follows:

**Fancy Fruits for Salad**

Unless otherwise specified, Fruits for Salad to consist of apricots, Bartlett pears, yellow cling peaches, pineapple, and Maraschino type cherries.

Description of Fruit. Fruit to be of good color for each variety, ripe, yet not mushy, pieces of each variety to be of uniform size, symmetrical and free from blemishes serious for Fancy Fruits for Salad.

Apricots—Bartlett Pears—Yellow Cling Peaches. Fruit of each variety to be at least equal to the Choice grade of that variety in cans of the same size as the can in which the Fruits for Salad are packed—allowance being made for the quarters, sixths, or eighths pieces.

Pineapple. Fruit to be at least equal to Fancy Tidbits after a second cook.

Maraschino Type Cherries. Fruit to be not smaller than 7 to the ounce, cut open-drained weight.

Fruits to be prepared as follows: Apricots in halves; Bartlett pears in halves or quarters; yellow cling peaches in halves, quarters, sixths or eighths; pineapple in sectors; Maraschino type cherries.

Proportions of Principal Varieties. The weight of the apricots to be not less than 18% or more than 30% of the total drained contents of the can.

The weight of the Bartlett pears to be not less than 21% or more than 35% of the total drained contents of the can.

The weight of the yellow cling peaches to be not less than 24% or more than 40% of the total drained contents of the can.

The weight of the pineapple to be not less than 9% or more than 16% of the total drained contents of the can.
The weight of the Maraschino type cherries to be not less than 4% nor more than 8% of the total drained contents of the can.

Weight of Fruit. Average drained weight of fruit in any parcel, determined by the standard method, to be 5 ounces for the 3-in. 8-oz. can, 5½ ounces for the 3½-in. 8-oz. can, 10½ ounces for the No. 1 Tall can, 13 ounces for the No. 2 Tall can, 19 ounces for the No. 2½ can, 68 ounces for the No. 10 can, with a tolerance of 5% provided the cans do not appear to be slack-filled.

Count. Each six ounces of contents of fruit and sirup to contain at least one piece of each of the five varieties. For example: An 18-ounce can requires at least 3 pieces of each variety; a 19-ounce can requires at least 4 pieces of each variety, etc.

Sirup. For the reason Fruits for Salad are largely a product repacked from cooked fruits previously canned in sirup, it is not practicable to pack Fruits for Salad to a going-in density of sirup. For the same reason it is practicable to pack Fruits for Salad to a cut-out density of sirup, though this is not practicable with deciduous fruits packed into cans in their raw state.

Fancy Fruits for Salad to be packed in sirup that will give a cut-out test on the finished product of 24% sugar by weight with a tolerance of 10% (that is down to 21%).

Choice Fruits for Salad

Unless otherwise specified, Fruits for Salad to consist of apricots, Bartlett pears, yellow cling peaches, pineapple and Maraschino type cherries.

Description of Fruit. Fruit to be of reasonably good color for each variety, ripe, yet not mushy, pieces of each variety to be of uniform size, symmetrical and free from blemishes serious for Choice Fruits for Salad.

Apricots—Bartlett Pears—Yellow Cling Peaches. Fruit of each variety to be at least equal to the Standard grade of that variety in cans of the same size as the can in which the Fruits for Salad are packed—all allowance being made for the quarters, sixths or eighths pieces.

Pineapple. Fruit to be at least equal to Standard Tidbits after a second cook.

Maraschino Type Cherries. Fruit to be not smaller than 12 to the ounce, cut open drained weight. Fruit to be prepared as follows: Apricots, halves; Bartlett pears, halves or quarters; yellow cling peaches, halves, quarters, sixths or eighths; pineapple, sectors; Maraschino type cherries.

Proportions of Principal Varieties. The same as for Fancy Fruits for Salad, except that there the minimum per cent of Maraschino type cherries may be 3 instead of 4, as in Fancy.

Weight of Fruit. The same as in the Fancy grade.

Count. The same as in the Fancy grade.

Sirup. The same as for the Fancy grade with the following change. Choice Fruits for Salad to be packed in sirup that will give a cut-out on the finished product of 20% sugar by weight with a tolerance of 10% (that is down to 18%).
The sirup is generally prepared from that drained from the original stock except that from the Maraschino type cherries. It is filtered, re-heated, and adjusted so that it gives the cut-out desired.

The rather wide variation in the percentage of the several fruits used is to provide for the use of fruit of different size and to feature one, as the peach or pear, if so desired. If a combination be used other than the five fruits named, then the fact would need to be stated on the label.

The packing of fruit salad has progressed to the point where special methods, and in a few cases, even special equipment, have been developed to do the work with speed and uniformity.

The fruit for this purpose is packed during the season in No. 10 cans, as that is the most economical package to handle in such large quantities. The character of the contents is stamped on the can but no label attached. When the can is to be opened, it is run through a double seamer with the closing rolls removed and cutter rolls substituted. This gives both capacity and ease of operation in removing the top. The can is then transferred to a regular “fruit in the can” washer or drainer but in this case without water connection and to drain the sirup by inverting the cans. The machines operate slowly so that 85 per cent or more of the sirup is recovered. In lieu of such a machine a small slat screen may be held against the open end and the can drained in a trough or tank. The sirup from the Maraschino style of cherries is not mixed with that from other fruits.

The fruits are next taken to the filling table and each variety emptied into its appropriate tin or pan, there being no mixing at this stage. The cans to be filled pass along the back of the table on a conveyor and each operator in turn adds the proper number of pieces of the kind being filled to give the number of services scheduled. The No. 1 can is supposed to have 4; the No. 2, 6; and No. 2½, 7 services. The first woman on the filling table, therefore, drops 4, 6, or 7 Maraschino style cherries; the next the same number of sectors of pineapple, a sector generally being one-sixth of a slice of the No. 2½ size; the third adds the service of apricot whether of one or two pieces; and the fourth and fifth, the peach and pear respectively. The cans are weighed and any deficiency made up, generally with peach or apricot. Six or seven women make a filling unit and it takes four units to keep one line in operation working at the rate of fifty cans per minute.

Any soft, broken, or otherwise defective fruit is kept apart to be used in jam or may be worked into a lower grade of mixed fruit for the cheap restaurant trade. The material is equally wholesome but less attractive.

In the meantime the sirup, except that from the Maraschino cherries, is mixed, heated, and filtered, usually through cloth, and, if necessary, sugar is added to bring it to the desired point to make it test 24 degrees on the cut-out. Since the choice grade is canned with sirup, there will be little difference between the sirup added at this time and in the final cut-out. The adjustment is made after a couple of trial batches.

The sirup is added hot, a short exhaust given to raise the contents to about 140° F., followed by a cook of from 6 to 10 minutes to protect against any infection from handling, and then cooled.

The packing of the product is easy and attended by little trouble, the most serious being the leaching of some color from the cherries, though
the newer dyes have eliminated most of that. It is well, however, to get at least one fruit, such as the apricot, between the cherries and pears.

Since the packing of Fruits for Salad is done from prepared fruit, the work can be done at any time or place where equipment is available and labor conditions are favorable.

The pack of fruit salad, according to the 1933 census, reached its maximum of 2,289,000 cases at that time, and has since dropped to 1,384,900 cases in 1934 and 1,339,600 cases in 1935.

Label Weights

Fancy (Sp. Gr. 1.10) : 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08) : 8Z Short, 8 ozs; 8Z Tall, 8¾ ozs.; Picnics—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Fruit Cocktail

The fruit cocktail is a natural variant from fruit salad, being a similar combination of fruits but in smaller regularly cut pieces. It is unfortunate that such a well planned creation, in reality a canned fruit supreme, should have been christened with such a misnomer and inappropriate name. It will not be a surprise if some other food combination be dubbed a "sow’s ear."

Fruit salad, or officially "fruits for salad," grew into popularity with such rapidity that it stimulated trials for other combinations and in 1933, H. E. Gray of San Jose, California, hit upon the idea of dicing the fruit after the fashion that fresh fruit mixtures are served in the better class dining places. He carried the matter a step further by using fresh pears, peaches, and Thompson seedless grapes, the fruits which can be obtained fresh at one time and the pineapple and cherry from canned stock. Only the choice grades of fruit were used and covered with a 40 degree sirup.

According to this method the fresh pears and peaches are prepared as for canning but the halves are run through a dicing machine to cut them into cubes of about one-half inch on each side, the irregular pieces and slivers being separated on a screen. The grape being small is left whole, the cherry cut in halves or may be sliced, and the slices of pineapple divided into sectors a half-inch wide on the outer edge. The different fruits are weighed in the proportions wanted in the mixture and then poured together in a tank of water where they are mixed uniformly and from which they are filled into the cans. Prepared in this way, the fruit retains its form, bright appearance in clear sirup, and maximum of flavor.

Other canners anticipated that this combination might enjoy a popularity like that of fruit salad and at once planned to pack on a quantity basis and to use all canned fruit so that the factory operation might be conducted at any time. Exceptionally efficient mechanical units have been designed to do the work with the minimum of hand labor.
The can opener is usually a single spindle closing machine with the rolls removed and a cutter put in their place. The draining may be done by running the cans through a washer to drain the sirup, or a screen may be put over the top and the can inverted in a trough. The dicers are mounted in pairs, one for the peaches and the other for the pears, each fruit being fed on a vibrating table which turns the halves on the flat face and feeds them to the knives which cut the pieces into slabs. The knives are very sharp, thin, stainless steel disks rotating at high speed so that the cut is made clean and sharp without any pressure. The disks are mounted on vertical spindles, alternating and overlapping in position so as to make half-inch slabs. By turning toward each other the disks assist in drawing the pieces straight through and as they emerge they are engaged by a vertical set of disks that slice the slabs lengthwise at right angles to the first cut. The pieces being discharged upon a rotor are turned at right angles to pass under a third set of knives which cut them into short or half-inch lengths. The cut fruit is discharged upon a slitted plate which vibrates to thoroughly mix the fruit and cause a separation of slivers and undersized pieces. A spray assists in handling the fruit at this point. The mixed fruit is conveyed to the filling machine where it is filled into cups set for the proper quantity to be delivered into each can. At the next step the grapes are added, then followed by the cherries, either split in halves or sliced, and finally the sectors of pineapple. The machine is compact and capable of handling 100 No. 1 cans per minute.

Apples, muscat grapes, and diced or shredded pineapple, and white cherries have also been used in some mixtures.

If canned fruit be used, the sirup is filtered and augmented by the addition of fresh sirup, except that from the Maraschino style cherries which is not used. Any shortage of weight on filling is made up by adding the mixture of peaches and pears.

The exhaust and cook are the same as for fruits for salad.

A patent for a "Method and apparatus for proportioning and mixing fruit" has been granted to H. E. Gray and A. M. Erickson, San Jose, California and is No. 2,045,737, issued June 9, 1936. The claim is as follows:

A method of producing a fruit mixture which comprises feeding different kinds of fruits to a plurality of dicing machines, regulating the quantity fed to each machine to maintain a predetermined proportion of each kind of fruit, discharging the diced fruit from each dicing machine to a flowing stream of water to wash and mix the diced fruit, directing the streams of water to wash and mix the diced fruit, directing the stream of water together with the diced fruit carried thereby, into a tank to further mix the fruit, and then delivering the water and fruit to a shaking screen to drain off the water and at the same time remove the small particles of fruit.

Fruits Spiced

Spiced fruit was formerly an important item in home canning but had only a small place in commercial manufacture, being conducted by a few firms that catered to those paying the higher prices. The extra costs and limited demand made it unprofitable for the average packer. The success of canned salads and diced fruits give promise of a revival of this specialty.

The packing cannot be reduced to a fixed formula as it is dependent upon the skill of the superintendent. The fruit needs to be selected for flavor which in turn usually means the use of certain varieties when fully ripe. The spicing may be very simple as the adding of a piece of cassia or other
whole spice to each can or jar, or it may be more in line with the confectioners' art of making an infusion of a spice mixture and adding it to the sirup, or of using the newer form of extracts. The object is to add a spice flavor that blends with that of the fruit in a pleasing manner but without any one spice dominant. No greater mistake can be made than to use a flavorless fruit as a vehicle to carry that of the spice. When infusions or vinegar extracts are used, they need to be made well in advance of the packing in order to attain proper blending. The addition of some acidity is frequently necessary and for this purpose a cider vinegar mellowed with age is first choice. Distilled vinegar, though offering the advantage of higher acidity, is too sharp and harsh by comparison. Lemon juice or citric acid are preferred in some instances. There is only one satisfactory method to arrive at a proper combination and that is by trial, then holding some of the finished product sufficiently long to determine the ultimate effect.

The cook on all spiced fruits should be as low as possible and be certain of sterilization, or to produce the proper consistency. Even though the flavor cannot be driven off from the sealed container it can be altered by high heat. The subsequent storage should be in a reasonably cool place.

Brandy or wine should not be used under any circumstances in commercial packing without first consulting both federal and state food officials.

Coloring by means of certified dyes is permissible but a declaration of their presence is required upon the label.

**GRAPEFRUIT**

*Citrus grandis*

This member of the citrus family is regarded generally as the most beautiful though not the most useful. It is native to the West Indies and was brought to Florida by the Spaniards early in the 16th century and later carried to most of the tropical countries. The name by which it was commonly known until the last half century was pomelo, said to have come from the Dutch “pompeelmoes.” The fruit is closely related to an Asiatic species *C. decumana*, introduced into the West Indies by Captain Shaddock sometime in the late 17th or in the early 18th century, known as pumelo, pommelo, or Forbidden Fruit, then later as shaddock, hence the confusion in the terms and the relationships. The term “grapefruit” by which the species under consideration is best known to us is of West Indian origin and ascribed to the fact that the fruits occur in clusters on the branches and thus present a gross arrangement somewhat like a cluster of grapes. The fruit presents a very striking appearance, being of large size, four inches or more in diameter, with a bright light yellow skin backed by dark green foliage.

The grapefruit is a more strictly tropical tree than the orange and can be grown in this country only in southern Florida, California, Arizona, and Texas. It is fairly large, round topped, closely branched, with large dark green ovate leaves. The flowers resemble those of the orange, and the fruits are large, globular, somewhat flattened at the ends, with a nearly smooth surface, and bright yellow color. In its wild state the skin is thick, and the white lining and tissues separating the sectors are bitter. Under cultivation this latter quality has been greatly modified so that in the ripe stage there is little bitterness, especially in certain varieties. The people of the West
Indies made little use of the fruit due to a superstition with which it was invested and which may have had some effect in delaying its horticultural improvement. Very little use was made of it in this country prior to 1890 but since the beginning of this century it has become common. In fact, it, or its juice, has become the morning appetizer upon thousands of tables as well as the opening course at other meals. The value of domestic production and importations from the West Indies amounts to several millions of dollars annually. Instead of being limited to the larger cities and commercial centers, it is distributed almost as widely as the orange. The grapefruit is best only when tree ripened, but for shipping fresh much of the fruit is taken when a little green for better resistance against rot and injury from handling.

Canned Grapefruit

Canned grapefruit is a recent addition to the list of products conserved by heat in a hermetic container and it is not strange that it should have gained popular favor in so short a time in view of the progress made by the fresh fruit. It has already acquired a very wide distribution, and is the only citrus fruit conserved in large quantity in this way. Since its canning has been done for only about twelve years, it would seem a simple matter to obtain the details concerning the history and development of the method but such is not the case.

There seems to be little or no doubt that the first attempt at canning was made at Auburndale, Florida, about 1912, but with a method so crude that the product was neither attractive to the eye nor satisfactory to the palate. The fruit was peeled and the segments with the surrounding membrane attached were merely cut into pieces. The cans were filled and sterilized in an open water-bath. The result was that the pulpy portion was broken down, the bitterness intensified by the heating, and the product a failure.

The first record of a successful attempt to can grapefruit is that by the Yankee Products Company operating in Porto Rico in 1919. Edmund Rushmore, manager, saw tons of the finest quality fruit going to waste because of inability to market it at the time it was in its prime nor any means for extending the market throughout the year. His associate on the Island, A. W. Houck, with Mrs. Houck, though they had no practical experience in canning knew the fundamental principle that foods heated to a proper degree in a hermetic container would keep. They made more than two hundred experiments in passing from grapefruit soup to whole plump sections or hearts with a natural flavor. It was a discouraging experience but not more so than having the product turned down as not merchantable because unknown. The same perseverance which produced the product also found a market, one which has grown more rapidly than for any other fruit product.

A small factory in which six persons were employed was established before the end of the year. Owing to the abundance of fruit and cheap labor, the peeling was done by hand as was also the stripping of the fibrous membrane surrounding the segments. Only the perfect segments were saved, those broken in the operation being discarded as waste. A thin bamboo spatula was devised for doing the stripping but later superseded by one made of stainless steel.
Previous experience on the Island had taught the advantage of low temperature cooking in sterilizing pineapple as a means of preserving the flavor and their most important contribution was the application of the same principle to grapefruit. Finding the narrow margin between a product which will keep and one ruined by disintegration and a cooked flavor was the difference between success and failure.

In 1920, Ralph Polk made a small pack of grapefruit juice and experimented in packing the fruit at Miami, Florida, and the following year made the first successful commercial pack in this country. The pack amounted to 11,000 cases, being chiefly experiments to determine the most practical procedure to follow in reducing the amount of labor in preparation, and the best cook to conserve all the natural qualities of the fruit, both matters to tax the resources of such an experienced packer. The possibilities were recognized at once by others and in the season of 1921 and 1922 fourteen factories were in operation and approximately 400,000 cases were packed in Florida, three factories were opened in Arizona, and a like number in California. As usual in such cases, lack of experience with consequent poor product, high cost of production, and overstocking the market before people had learned the merits of the product, resulted in the failure of all but two of the companies. Since then the development of the industry has been gradual and orderly until now there are about thirty factories.

The rapidity in growth of the industry is clearly indicated by the statistics from the packing in Florida.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921-1922</td>
<td>11,000</td>
</tr>
<tr>
<td>1922-1923</td>
<td>400,000</td>
</tr>
<tr>
<td>1923-1924</td>
<td>200,000</td>
</tr>
<tr>
<td>1924-1925</td>
<td>350,000</td>
</tr>
<tr>
<td>1925-1926</td>
<td>400,000</td>
</tr>
<tr>
<td>1926-1927</td>
<td>700,000</td>
</tr>
<tr>
<td>1927-1928</td>
<td>600,000</td>
</tr>
<tr>
<td>1928-1929</td>
<td>957,000</td>
</tr>
</tbody>
</table>

The increase continues though not so rapidly, the total quantity for Florida and Porto Rico since 1929 being in excess of 2,000,000 cases annually. Very little juice was packed prior to 1928 but by 1929 it became such an important item that it was listed separately, the pack being 287,000 cases that year and it continues to increase. The packing in the West was discontinued after 1924 as the grapefruit has a different, and to many persons, a less agreeable flavor after canning, a much thicker skin, costs more, and necessitates the use of more labor in preparation, so cannot compete on equal terms. In the meantime, Texas trees have come into bearing and promise to become a factor in the canning market. It is interesting to note that the Florida production, disregarding the abnormal season of 1922-1923, has been about one and one-half times as rapid as that of Hawaiian pineapple during the corresponding period in its development. The serious handicap in the canning of this fruit is the amount of labor required as machines have not been devised to remove the skin and the membrane surrounding the segments. In addition, the inexperienced have rushed into the packing, injuring not only themselves but also others who had acquired wisdom by hard toil.

Grapefruit, when canned, retains its qualities better than other citrus fruits so that it is advantageous to conserve it in that form even though it
requires more hand work in preparation and more care in sterilization to obtain both an attractive as well as a full-flavored article than do most fruits. This tends to limit its packing to a few firms and to keep it from becoming cheap.

**Raw Material**

The first essential in the production of a good product is to use only tree-ripened fruit in order to have the full development of sugars, acids, and the characteristic fruit flavor. Concurrent with the development of these desirable qualities is a lessening in the bitter principle found in greatest abundance in the white layer of the peel and fibrous envelope of the segments. This is abundant in the immature state in all grapefruit but nearly disappears in the finer varieties when ripe. It is present in greater amount in western than in eastern grown fruit. Gas-colored fruit, simulating the mature, may pass as ripe fruit on the fresh market but is a poor substitute for nature's process in effecting internal changes and hence not desirable for canning. The period for packing is about six months, from December to May. Early fruit, that taken in October and November, is canned but is generally of poor quality and a detriment to the industry.

The fruit used for canning are those which are irregular in shape, show skin discoloration from spraying, rubbing, sunburn, or other cause, excessive size or in other ways not suitable for the fresh market. During the peak of the season when the market cannot absorb all the fruit, the excess is diverted to this use. A large part comes from the fresh fruit-packing houses and some from that whipped from the trees by the wind. Small fruit and light fruit are uneconomical to handle. The average cost of the fresh stock is about twenty dollars per ton.

The fruit is brought to the factory in crates, boxes, or frequently loose in wagon beds and if in the last, they are emptied into large bins for temporary holding. Grapefruit possesses considerable resistance to decay, so that it can be held for a week or more without injury but needs to be kept cool and in sufficiently small units to prevent sweating or interfering with normal respiration. As with nearly all products, there is a gain in quality and a higher yield when handled promptly at its prime. The fruit used for canning must comply with the Federal standards for fresh fruit, that is, have not less than seven parts of soluble solids for each part of acid expressed as citric acid. This requirement is not difficult for ripe fruit.

**Sizing**

The fruit obtained from the packing houses is practically all graded for size and this has proven of sufficient advantage in the several operations to justify mechanical grading of all into at least the three standard packing sizes, 54, 64, and 70 per box. This is done by means of spreading ropes, rubber tubes or roller graders. At some factories only two sizes are used and the division made upon appearance. The smaller fruit, unless of extra quality, is used in the making of grapefruit juice. The fruit is then ready for washing which is done best by means of strong sprays of water directed upon them so as to reach the entire surface.

**Peeling**

Two lines of procedure are now open, one to peel-the fruit by means of a knife and the other to do part of the work with lye. The former is the
older method though it has been largely superseded in this country by the lye treatment. Hand peeling is preferred in Porto Rico where fruit and labor are both cheap.

In hand peeling, the first operation is to cut off one or both ends to the depth of the peel but not deep enough to open the segments. The remaining peel is then slit or scored at points corresponding to quarters, sixths, or eighths, making the incisions parallel with the core. The fruit is then taken by men with considerable strength in their fingers who tear off the peel taking with it as much as possible of the white portion down to the capsule. It cannot all be pulled off, in which respect it differs from the orange. The use of six or eight scores is an aid in getting rid of some of the deeper portion of the white tissue. Formerly a coring tube was thrust through the fruit to remove the core and a considerable portion of the seeds but that has been improved upon by the method of stripping the segments.

At a few factories a knife is used to trim off the outer layer of membrane on three or four segments, then the pulp stripped from the partition membranes and the work repeated until all the segments are removed, a slow process but preferable for slightly over-ripe fruit.

The more common method is to either break the fruit apart along the line of one of the dividing segments or to cut it into quarters. In the next operation a stripper is inserted next to the dividing segment and the pulp loosened along its side and then from the back, thus taking it out in one whole piece. The stripper at first consisted of a flat piece of bamboo about six inches long, a half-inch wide, and a sixteenth of an inch thick with rounding edges so that the cells would be pried loose from the fibrous portion rather than cut. Aluminum and stainless steel strippers of similar size and shape are now used. The objection to cutting is that the cells are full of juice and cutting causes them to bleed and collapse producing a shrunken ragged appearance. Each segment is removed in turn, the perfect ones being laid on flat pans to be picked up by fillers and the broken segments dropped directly into cans. In the islands where the fruit is very cheap, the fruit is quartered and the cut segments discarded as the gain in time removing the pulp from the other segments counterbalances the loss in material. With good workmanship, only from 15 to 20 per cent of the segments are broken, but with ordinary workers the breakage is more nearly double these figures. For this reason the better packers prefer that the segments be placed on plates and be filled into the cans by other persons to insure a higher grade of packing. Segmenting is slow work. An operator can prepare only about 100 pounds of fruit per day or not more than four cases.

**Lye Peeling**

The lye peeling process seems to have been developed by two or three persons working along independent lines. Mr. Polk tried it out first in the season of 1922 and 1923, then abandoned it temporarily the next season, and again returned to it. The Citrus Fruit Exchange at Eagle Lake, Florida, tried it in 1923 and during the same season it was used by the Van Camp Sea Food Company at Los Angeles, California. It was from the latter place that it was first described by H. M. Miller in *The Canner*, February 9, 1924.
The procedure consists in first submerging the fruit in boiling water from 4 to 6 minutes or a sufficient time to loosen the outer or yellow peel from the deeper layers of white tissue. This outer skin is then scored as in the former style of peeling and the men can easily tear the skin off leaving a ball of segments with a thin layer of white tissue on the outside.

The second step in the operation consists in subjecting the partially peeled fruit to the action of hot lye either in a bath or under sprays. The principle is the same as in the removal of the skin from peaches and some other fruits and vegetables, that is, the lye has a rapid disintegrating or dissolving effect upon certain tissues and only a very slight effect upon others during the same brief period of exposure. The effectiveness of the method depends upon three factors: the temperature, strength of the solution, and time of exposure. The temperature of the solution is much more important than is generally recognized for when held at or near the boiling point a weaker solution can be used with better results than a stronger one at only 170° to 180° F., furthermore, the time may be cut in half or less, this factor being of much greater importance in the handling of grapefruit than with some other products.

The earlier devices for lyeing grapefruit consisted of a bath with a heating coil and a conveyor to carry the fruit through in a predetermined time. The incoming fruit chilled the solution, thus slowing its action and as a consequence the time of the fruit in the bath was correspondingly lengthened. In the end the peel was removed but with much more heating of the fruit than was desirable for ease in stripping. With peaches it is possible to preheat in a water bath so that the lye will not be chilled to the same extent and thus reduce not only the time in the lye but also the strength of the solution. Preheating the grapefruit does not eliminate the softening effect upon the tissues which increases the difficulties in stripping. The spray method possesses the advantage that the lye can be kept to very near the boiling point just before it strikes the fruit and owing to the amount present at any one time it has a lesser effect in heating the fruit. The action is more superficial. As a preliminary step, the fruit can be sprayed with hot water. In the tank system the solution has been described as varying between 2 and 5 per cent alkali, probably most often between 3 and 5 per cent, and the time of submersion at from 25 to 35 seconds. In the spray method, the solution is held between 1.5 and 2.5 per cent and the time of application to about 15 seconds. The apparatus for this purpose is the same as that used for peach peeling. The adjustment of the factors in lye peeling have to be worked out by each individual according to his particular conditions.

Immediately after the lye treatment, the fruit is subjected to strong sprays of water to remove the dissolved tissue and any traces of lye. It is of the greatest advantage that the water used for the purpose be cold in order to chill the fruit and prevent the softening which interferes with stripping of the sections.

A patent, No. 1,514,774, issued November 11, 1924, to E. H. Lefevre, Avon Park, Florida, provides that the fruit be carried on a conveyor through a lye solution, sprayed with lye from above, then through a washing and chilling bath, finally through a drying chamber and mechanism for distributing the fruit to the segmenting tables. A patent, No. 1,719,631,
issued July 2, 1929, to A. W. Scott, Clearwater, Florida, is for improvements upon the foregoing.

The peeled fruit is delivered to the stripping tables where the work of removing the segments is conducted in essentially the same manner as that already described but with the advantage that the stripping can be done more readily along the side membranes with only a thread remaining to be removed from the back. It speeds the work, reduces the number of broken pieces, and lessens the waste. In the Polk method, the stripper impales the fruit on a fork mounted on a spindle attached to the table. The fruit is held steady and the segments presented in a position to be removed with the fewest movements. In the lye treatment it is possible for fewer persons to remove the yellow peel and to double the amount of segmenting which can be done by one operator, or to prepare about eight cases of No. 2 cans per day. The waste is reduced 12 to 15 per cent.

A modification in the preparation of the lye-peeled fruit is to cut each section through the middle as nearly as may be possible, remove the seeds, and leave the inter-segment membrane in place. This lessens the labor and the claim is made that the membrane is no more objectionable than is that from the orange. This variation is covered by patent No. 1,759,464, May 20, 1930, issued to P. Phillips, Orlando, Florida.

Filling

The pans of segments are taken to a special table where the cans are filled by hand, either dropping the segments into the cans without any arrangement or by arranging them in layers with the curvature of the segment corresponding to that of the can. Those who do the filling give attention to selecting the perfect segments for the careful packing and the small and broken ones for the lower grade. The inspection at this point also serves as a check upon the different workers.

When the fruit is layered, it requires about 20 ounces to fill the can and the interstices leave room for about one and one-half to two ounces of sirup or two ounces of dry sugar. The sirup in this case is made about 65 degrees as the proportion of sugar to the acid fruit is no more than needed to make it reasonably sweet. The filling has to be done by hand as the sirup finds its way between the pieces very slowly, it often being necessary to run the stripping knife down along the side of the can to aid the movement. In some cases the sirup is put in the can ahead of the fruit but this is not to be recommended. A weighed portion of dry sugar may be used, either before or after packing the fruit and is finally topped with a very little juice to give the proper headspace.

When the fruit is filled into the can without layering it requires from 16 to 17 ounces to fill the No. 2 can and the interstices are filled with a sirup testing from 35 to 40 degrees. This will give very nearly the same result in the cut-out as the heavier sirup on the 20 ounce fill. The aim is to have a sirup which will test between 16 and 18 degrees after the sugar has become diffused through the entire contents. Some adjustment is made to correspond to the quality of the fruit. The added heavy sirup serves a further useful purpose in slightly toughening the segments so that they hold their shape and not break apart.
Exhausting and Cooking

As grapefruit is injured by a high temperature, especially in the open, the exhausting is done at a comparatively low temperature, 175° F. from 15 to 18 minutes, to be certain that all air is driven out of the tissues. The cover may be put on and clinched to prevent the fruit expanding and projecting above the top of the can, especially if steam instead of hot water be used in the exhauster. The cans are then sealed and given a cook at from 20 to 25 minutes for 8 ounce and No. 1 cans; 30 to 35 minutes for No. 2, and 40 minutes for No. 5 cans at 180° F., followed by cooling to air temperature. The water bath is used almost exclusively for cooking in batches as it gives a uniform and positive effect without any sudden changes. The grapefruit being highly acid and not having resistant organisms associated with it make sterilization easy and might be done at even a lower temperature but for the fact that heat conduction is irregular and uncertain. The continuous cooker is not used as any agitation of the hot fruit tends to break it apart and injure its appearance. The flavor is conserved best by keeping the temperature as low as possible rather than by using a higher temperature for a shorter time.

The fruit is also vacuumized mechanically and sealed in from 23 to 25 inches of vacuum in which event the time of cooking must be nearly doubled to compensate for the lack of heating in the exhaust box.

The No. 2 can is the one most used and the plain tin is preferred to the lacquer-lined. The plain tin gives a product with a better appearance and also a slightly better flavor. Its disadvantage is that unless the exhausting be well done there is a tendency to rusting in the head-space with formation of black deposits on the metal which later are distributed on the fruit. The preventive measure is obvious and the same precaution will delay or avoid springers. Hydrogen swells are more frequent in inside enamel cans than in plain tin.

Label Weights Recommended

Grapefruit (Sp. Gr. 1.05): 8Z Short, 7½ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

Grapefruit Juice

This product is contemporary with canned grapefruit but successful manufacture and distribution did not arrive until a few years later. In the early efforts there was too much bitterness from the albedo or white lining of the skin and a turpentine-like flavor developed due to the oil from the yellow layer with the result that the product was not pleasing at the start and the deterioration continued with time. With a better understanding of the causes of these defects has come improved technique in manufacture.

The stock used for juice is the smaller size fruit received for canning and other surplus that may be suitable. The important factor is that it be well ripened on the tree. The fruit is washed, cut crosswise in halves, the pulp burred out by a device similar to that used in soft drink service though made larger, or the halves are pressed between a cup and cone so that the
juice is forced out without liberating the oil from the peel. These are the most economical methods for recovering the juice but they are so vigorous that some of the objectionable material may contaminate the product. Samples of juice made by first peeling the fruit as for canning and then pressing lightly were exceptionally fine but the extra labor adds materially to the costs.

The juice is immediately passed through a fine screen or pulper to remove seeds and all coarse bits of tissue. As it is not filtered clear, the very fine pulp gives it a whitish or milky appearance. Removal of all the suspended solids changes its character and makes it less desirable. Sugar is added in the proper amount to give the needed sweetness as the natural juice is too acid to suit most persons. The juice averages from about 6 to 6.5 per cent sugar and seems to be liked best when this is increased to about 15 per cent, somewhat less for juice running under 1.25 per-cent acidity and more for that with an acidity above 1.5 per cent. If sirup be added instead of dry sugar, it should be saturated or at 65 per cent to avoid diluting the juice with water. The sweetened juice is preferably filled into containers at once, exhausted and sterilized. The object is to have the minimum exposure to the atmosphere and one heating for the shortest period and at the lowest temperature which will insure keeping. Heating in a jacketed kettle, by flash coils, and other devices, has been tried but has not been found superior to the simple method just described. The time in the exhaust box is from 12 to 15 minutes at 175° to 180° F. or sufficient to bring the temperature of the juice to 170° F. for sufficient time to drive out all the gases. The time in the cooker is from 15 to 20 minutes for cans under the No. 2 and from 25 to 30 minutes for the No. 2, No. 2½, and No. 3. The heat penetration is more rapid and uniform than with the canned fruit but any material lowering of the time and temperature at any place should be based upon experiments conducted throughout the season under factory conditions. Vacuumizing may be done by machine but due allowance needs to be made by increasing the final cooking. Little packing is done in glass as light causes a change from the clean whitish color to a sort of dull gray. The cans are filled so that there is little head-space since it improves the appearance of both the can and contents but increases the possibility of springers in those kept in a warm place or shipped to a warm section of the country. The storage should be cool as far as that may be possible.

Label Weights

8Z Short, 7 fd. ozs.; 8Z Tall, 7¾ fd. ozs.; Picnic or No. 1 East, 9½ fd. ozs.; No. 300, 13½ fd. ozs.; No. 1 Tall, 15 fd. ozs.; No. 303, 15 fd. ozs.; No. 2, 1 pt. 2 oz.; No. 2½, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; No. 10, 3 qts.

UNITED STATES STANDARDS FOR GRADES* OF CANNED GRAPEFRUIT

Definition

CANNED GRAPEFRUIT is the product prepared from properly matured fruit of the grapefruit tree (Citrus Grandis) after having been properly trimmed, peeled and washed; membranes comprising the segment walls, cores and seeds removed; the

* These standards for grades are so framed as to exclude substances not mentioned and in each instance imply that the product is clean and sound.
segments separated; with or without the addition of water and/or sugar; packed in hermetically sealed containers, and sterilized by heat.

**Grades of Canned Grapefruit**

**U. S. Grade A** (Fancy) canned grapefruit is composed of segments of which not less than 80 per cent by weight are whole or practically whole; are reasonably uniform in size; have a typical bright color, and possess a firm but not “fibrous” texture. The sirup surrounding the segments is reasonably clear, and tests not less than 18° Brix. The drained net weight of the fruit is not less than 60 per cent of the capacity of the can. The product is practically free from defects; possesses a typical tree-ripened fresh grapefruit flavor, and scores not less than 90 points when scored according to the scoring system outlined herein.

**U. S. Grade B** (Choice) canned grapefruit is composed of segments of which not less than 60 per cent by weight are whole or practically whole; have a typical bright color which may be slightly amber, and possess a firm but not “fibrous” texture. The sirup surrounding the segments is reasonably clear, and tests not less than 16° Brix. The drained net weight of the fruit is not less than 55 per cent of the capacity of the can. The product is reasonably free from defects; possesses a typical grapefruit flavor, and scores not less than 75 points, and need not score more than 89 points when scored according to the scoring system outlined herein.

**U. S. Broken** (Broken) canned grapefruit is composed of segments and/or portions of segments of which not less than 75 per cent of the weight of drained fruit shall consist of whole and/or broken segments, but not over 15 per cent by weight of the broken segments shall be smaller than one-half inch in two dimensions. The product has a typical bright color which may be slightly amber, and possesses a firm but not “fibrous” texture. The sirup surrounding the fruit is reasonably clear, and tests not less than 14° Brix. The drained net weight of the fruit shall not be less than 60 per cent of the capacity of the can. The product is reasonably free from defects; possesses a typical grapefruit flavor, and scores not less than 60 points when scored according to the scoring system outlined herein; provided, that the factor of UNIFORMITY OF SIZE shall not be scored in grading this class of grapefruit.

**Off-Grade** canned grapefruit is grapefruit which fails to meet the requirements of the foregoing grades, or, when any one of the grading factors, with the exception of UNIFORMITY OF SIZE, falls in the subdivision D.

*Note*—Cognizance is taken of the fact that canned grapefruit is sometimes packed without sugar for certain classes of trade. Certificates of grades covering canned grapefruit so packed shall carry in connection with the statement of grade, the following statement: “Water pack,” and the Brix readings hereinbefore specified are waived.

**Explanation**

“14° Brix” means that the sirup shall test 14° at 68° Fahrenheit when tested with a Brix spindle or hydrometer, calibrated at that temperature.

“Practically whole” means that the conformation of the segment has been preserved to the extent that the segment is not less than 75 per cent of its original size, but no piece shall be considered practically whole which weighs less than one-fourth ounce, or which has been excessively trimmed.

“Broken segments” are segments or portions of segments which fail to meet the description of “practically whole” segments, but are not less than one-third of the size of the segment of which the broken segment was originally a part. Portions of the segments which are joined together by a “thread” of membrane, or “rag,” are considered broken.

“Excessive trimming” is defined as that quantity of trimming which destroys the normal shape of the segment.

“Capacity of can” means weight of the volume of distilled water at 68° Fahrenheit the can will hold when completely filled.

**Prerequisites to Grading**

**FILL OF CONTAINER**—Cans of grapefruit shall be filled to the maximum capacity consistent with the maintenance of quality. Cans of grapefruit will be con-
sidered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container, and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned grapefruit that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

A certificate of grade covering canned grapefruit that does not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,

"Below U. S. Standard—Slack Fill"
"Contains Excess Added Liquid"

DRAINED NET WEIGHT AND HEAD SPACE REQUIREMENTS—
Drained net weights of grapefruit are determined by emptying the contents of the can upon a circular sieve of proper diameter containing 8 meshes to the inch (.097 inch perforations), and allowing to drain for two minutes. The sieve diameters used are: 8 inches for No. 2 size cans or smaller, and 12 inches for No. 2 1/2 size cans or larger.

The minimum drained net weight and the maximum head space allowable in the sizes commonly used in packing grapefruit are shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Min. Dr. Net Wt. (in ounces)</th>
<th>Max. Head Space Allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broken</td>
<td>Grade A</td>
<td>Grade B</td>
</tr>
<tr>
<td>8Z Tall</td>
<td>5.21</td>
<td>4.77</td>
</tr>
<tr>
<td>No. 1 Eastern</td>
<td>6.56</td>
<td>6.02</td>
</tr>
<tr>
<td>No. 2</td>
<td>12.33</td>
<td>11.30</td>
</tr>
<tr>
<td>No. 5</td>
<td>35.53</td>
<td>32.57</td>
</tr>
<tr>
<td></td>
<td>7.6</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>9.7</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Ascertaining the Grade

The grade of canned grapefruit may be ascertained by considering, in addition to the foregoing requirements, the following factors: Uniformity of Size, Absence of Defects, Character of Fruit, and Flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Uniformity of Size</td>
<td>10</td>
</tr>
<tr>
<td>II. Absence of Defects</td>
<td>25</td>
</tr>
<tr>
<td>III. Character of Fruit</td>
<td>40</td>
</tr>
<tr>
<td>IV. Flavor</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Note.—When grading broken segments, the factor of UNIFORMITY OF SIZE shall be disregarded.

ASCERTAINING THE RATING FOR EACH FACTOR—The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 4 to 6 means 4, 5, and 6.

I. UNIFORMITY OF SIZE—The factor of uniformity of size, consideration is given to the uniformity of size of the segments, and their thickness.

(A) To receive a rating within the highest group, 9 to 10 points, for this factor, the segments must be practically uniform in size.

(B) If the segments are reasonably uniform in size and thickness, a credit of 7 to 8 points may be allowed.

(C) If the segments are fairly uniform in size and thickness, a credit of 4 to 6 points may be allowed.

(D) If the segments are noticeably lacking in uniformity of size and thickness, a credit within the range of 0 to 3 points may be given.
II. ABSENCE OF DEFECTS—In the factor of absence of defects, the element of workmanship is considered. The presence of portions of membrane, irregularly cut segments, pieces of core, peel, blemishes or seed are to be reflected in the scoring of this factor.

(A) If the product is practically free from the defects mentioned, a credit of 23 to 25 points may be allowed.

(B) If the product is reasonably free from such defects, a credit of 20 to 22 points may be allowed.

(C) If the defects are prominent, a credit of 17 to 19 points may be allowed.

(D) If the defects are decidedly prominent, a credit within the range of 0 to 16 points may be allowed.

III. CHARACTER OF FRUIT—In the factor of character of fruit, consideration is given to the texture of the fruit and whether it retains its original conformation without tendency to disintegrate. The condition of the flesh, whether tender or, contrariwise, tends to be “fibrous” or tough, is to be noted in this connection. The maturity of the fruit has a direct bearing on the score accorded this factor.

(A) To receive a rating within the highest group, 36 to 40 points, for this factor, the fruit must be mature and tender, yet firm to the extent that it may be handled readily without breaking.

(B) If the fruit is tender, but slightly soft, a credit of 31 to 35 points may be given.

(C) If the fruit is noticeably lacking in character, or the pieces lacking uniformity in tenderness and maturity, is flaccid or mushy, a credit of 26 to 30 points may be given.

(D) If the fruit is tough or “fibrous” or, contrariwise, badly broken down or mushy, a score within the range of 0 to 25 points may be given.

IV. FLAVOR—The determination of the rating for flavor shall be based upon the flavor of the fruit and the sirup surrounding the fruit, and shall be classified from the standpoint of palatability.

(A) If the fruit possesses the fine, distinct flavor of tree-ripened grapefruit, a credit of 23 to 25 points may be allowed.

(B) If the fruit possesses a good flavor, a credit of 20 to 22 points may be given.

(C) If the fruit possesses a fairly good flavor, with but slight bitterness or slight terpine flavor, if any, a credit of 17 to 19 points may be allowed.

(D) If the product possesses an “off” flavor, or is distinctly disagreeable to the taste for any reason, a credit within the range of 0 to 16 points may be given.

General Observations

Grapefruit and grapefruit juice packing are both still in the formative stage. Very little special machinery is used, the lineup being units taken from other lines of packing or at best slight modifications made to adapt them to these products. Improvements are certain to be made, the most needed device being that for removing the segments. The line consists of a grader, washer, heater, yellow skin peeling table, lye peeler, washer, stripping table with conveyors to handle the fruit to and away from the table, filling table, exhauster, closing machine, cooker, and cooler. The amount of handwork is excessive. To operate one line to pack 2,000 cases of No. 2 cans per day, which is a small plant by comparison with many other lines, requires 15 men to remove the yellow peel, 125 women to strip the segments, 10 fillers, 5 forewomen, 3 inspectors, and 12 men to operate the machinery and handle the fruit through the factory. The steam plant needs to be about 80 horsepower.

A ton of fruit yields only 23 to 25 cases of canned grapefruit so that the waste in peel, core, juice, etc., amounts to more than 55 per cent, the value of which is low. A recent bulletin from the Department of Com-
merce states that a box of fresh grapefruit weighing 70 pounds will produce one case of No. 2 cans with a net weight of 30 pounds of fruit. An analysis of dried waste is said to indicate that it is about equal to corn as a stock food but packers have not found a practical way of utilizing it.

**Composition**

The grapefruit is intermediate between the lemon and the orange in acidity and sugars and has a flavor unlike either. The juice is not as smooth and full flavored as the orange nor does it make a beverage equal to lemonade. However, it has individuality and a quality of its own which is highly appreciated.

The chemical composition as given in Circular No. 50, United States Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Florida Fruit</th>
<th>California Fruit</th>
<th>Florida Juice</th>
<th>California Juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>31%</td>
<td>34%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>90.1%</td>
<td>87.7%</td>
<td>90.1%</td>
<td>89.3%</td>
</tr>
<tr>
<td>Protein</td>
<td>.5%</td>
<td>.5%</td>
<td>.4%</td>
<td>.4%</td>
</tr>
<tr>
<td>Fat</td>
<td>.2%</td>
<td>.2%</td>
<td>.1%</td>
<td>.1%</td>
</tr>
<tr>
<td>Ash</td>
<td>.54%</td>
<td>.4%</td>
<td>.4%</td>
<td>.4%</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>8.7%</td>
<td>11.2%</td>
<td>6.65%</td>
<td>9.8%</td>
</tr>
<tr>
<td>Fiber</td>
<td>.3%</td>
<td>.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar</td>
<td>6.5%</td>
<td>6.6%</td>
<td>6.65%</td>
<td>7.03%</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>1.17%</td>
<td>2.23%</td>
<td>1.42%</td>
<td>1.77%</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>38.6</td>
<td>48.6</td>
<td>41.7</td>
<td>190.</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>175</td>
<td>220</td>
<td>190</td>
<td>190</td>
</tr>
</tbody>
</table>

The grapefruit has a bitter principle, nargarin, found in greatest abundance in the white layer of the skin and in the membrane surrounding the segments. It is particularly abundant in immature fruit so that the fruit packed early in the fall is likely to have an excess, not only affecting the flavor adversely but may separate and form deposits on the fruits in the form of crystals, and in the case of juice to cause a milky or turbid appearance. It also combines with the metal of the can to cause an astringent bitterness. While not harmful, it is objectionable. The remedy is easy, to pack only ripe fruit. This phase of the subject was investigated by C. R. Fellers and reported in *The Glass Packer*, December, 1929.

**F. I. D. No. 182**

*Grapefruit, pomelo,* is the sound, mature fruit of *Citrus grandis,* Osbeck. The juice of the mature fruit contains not less than seven (7) parts of soluble solids to each part of acid calculated as citric acid without water of crystallization.

**GRAPES**

*Vitis sp.*

The culture of the grape antedates historical records. Legend credits Noah with becoming a vineyardist after the flood and the promptness with which he made wine and experienced its physiological effects leaves one to infer that he must have had previous experience or that he was remarkably apt in his chosen vocation. The numerous other Biblical references clearly indicate the importance which the grape attained under cultivation in early times.
De Candolle, who was the foremost investigator of the origin of cultivated plants believes that the cultivated grapes of Europe had their origin in a large area of western Asia of which the Caucasus region is about the center. They were distributed from this point as far south as climatic conditions permitted and west and east across both continents. The distribution was by seeds at first but from early Roman times propagation was conducted by cuttings. The parent species was *Vitis vinifera* or wine grape and the numerous varieties of this as well as the table and raisin grapes are the result of centuries of cultivation under widely varying conditions.

This continent also has native species of grapes but the one from which most of the varieties have been developed is *V. labrusca*, which occurs on the Atlantic Coast. The Concord and Catawba are the outstanding types. Some good varieties have been developed from the southern and southeastern varieties and hybridizations with European strains have also taken place. The native grape is better adapted to conditions here than are the European varieties except on the Western Coast where the conditions are similar to those in the countries bordering upon the Mediterranean, and the only section in which the raisin, foreign wine, and table grapes can be grown. The native grapes have a very different flavor from the foreign and are frequently referred to as "slip skin" owing to the ease with which the skin separates from the pulp. The skin on the European varieties is adherent to the pulp. The distinguishing feature of the raisin grape is the very high sugar content so that in a dry place it will cure in the sun without spoilage.

**The Plant**

The plant is a woody climber having strong tendrils opposite the leaves by which it supports itself on any convenient object. It varies greatly in size from small, about four feet in height with a corresponding spread, to fifty feet spread. The leaves vary through simple lobed to compound and are most often from three to four inches across. The flowers are greenish and inconspicuous, occurring in panicles opposite the leaves. In the eastern varieties the flowers are complete but in the native they are not, both male and female may occur on the same plant or may be on different plants. The fruit occurs in clusters consisting of a fleshy berry with a seed surrounded by juicy pulp. Seedless varieties, such as some of the raisins, have merely abortive seeds. The colors vary greatly. The plant is only moderately hardy, many of the vinifera strains being injured by moderate freezing.

The culture of the grape is a large industry abroad, especially in sections devoted to the production of raisins and wine and while it does not hold the same relative position in this country, it is one of the important fruits. In this country raisins are produced only in California which is also true for the eastern type of table and wine grape. That state naturally becomes the principal growing center. The native grapes are produced in greatest abundance in New York and Ohio about the Great Lakes. The principal part of the crop is marketed fresh as the fruit is particularly pleasing in the raw state and has the further advantage of keeping reasonably well for a time after harvesting. Wine grapes are also marketed fresh for the manufacture of wine in the home, carloads being sent from the
West to the eastern markets annually and particularly during the period of prohibition. Unfermented grape juice is also a popular beverage.

Canning

The grape holds a relatively unimportant place as a canned fruit which is the more surprising considering the favor in which it is held fresh, and while the flavor is changed by the cooking, it is not altered to the extent that are many other fruits. White grapes only are used in commercial canning, the Niagara in the East and the Muscat and Thompson’s Seedless in the West. The former softens in cooking, the skins break and some slip, while the latter softens less, the fruit splits but the skins remain adherent. The Niagara has seeds that are a disadvantage when eating but the Muscat may be obtained nearly seedless, and the Thompson’s Seedless without any, as the name indicates. The important difference is in the flavor, the Niagara having a sweet acid or foxy flavor characteristic of the native grape while the Muscat is sweet with a peculiar varietal flavor and the Thompson Seedless is very suggestive of the raisin. Colored grapes are almost certain to become of a bluish gray color in cans and thus unattractive. The Thompson’s Seedless has been packed in quantity only since 1927, when S. F. Triplett, Ceres, California, invented a stemmer to do that part of the work. Hand-stemming was too costly. The new machine is based upon the principle of the stemmers used in the wine industry.

Grapes for canning are picked when ready to turn soft, are stemmed, and during that process those which are defective are thrown out. In the East the grapes are not graded, but in the West the Muscats are graded in keeping with the custom for other fruits. The screens used are 26, 24, 21, and 20 thirty-seconds of an inch in diameter. The fruit is washed and the cans filled just below the level of the top with sirup added according to the schedule shown in the standards.

The Niagara grape makes a more attractive product by exhausting at not too high temperature, about 180° F. for 10 minutes rather than at 212 for 4 or 5 minutes. Less difference is produced by the lower temperature upon the Muscat grape though preference might well be given there to the lower and longer exhaust. Cooking is ordinarily 14 minutes at 212° F. for No. 2½ cans.

It requires on an average 37.5 pounds of Muscat grapes per case for No. 2½ cans; 62.5 pounds for No. 10 cans, sirup grade, and 74.4 pounds for No. 10 cans, water grade.

Effect of Varying Degrees of Sirup on Grapes, Cut-out Weight of Fruit and Sirup

Weight of fruit, 550 grams (19.5 ounces) to No. 2½ can.

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>857</td>
<td>425</td>
<td>432</td>
<td>12.2</td>
</tr>
<tr>
<td>20</td>
<td>883</td>
<td>423</td>
<td>459</td>
<td>21.1</td>
</tr>
<tr>
<td>30</td>
<td>907</td>
<td>416</td>
<td>491</td>
<td>24</td>
</tr>
</tbody>
</table>

(Table continued on next page)
Niagara Grapes (16 ounce jar):

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>477</td>
<td>277</td>
<td>200</td>
<td>13.6</td>
</tr>
<tr>
<td>10</td>
<td>392</td>
<td>206</td>
<td>186</td>
<td>18.8</td>
</tr>
<tr>
<td>20</td>
<td>424</td>
<td>223</td>
<td>201</td>
<td>20.0</td>
</tr>
<tr>
<td>30</td>
<td>422</td>
<td>186</td>
<td>236</td>
<td>22.3</td>
</tr>
<tr>
<td>40</td>
<td>456</td>
<td>213</td>
<td>343</td>
<td>27.2</td>
</tr>
<tr>
<td>50</td>
<td>498</td>
<td>234</td>
<td>264</td>
<td>33.7</td>
</tr>
</tbody>
</table>

Standards, California Muscat Grapes

Fancy Grade. Fruit to be of very fine quality, ripe, free from blemishes serious for the grade, and uniform in size. Sirup, 40 per cent sugar when packed.

Choice Grade. Fruit to be of fine quality, ripe, free from blemishes serious for the grade and uniform in size. Sirup, 30 per cent sugar when packed.

Standard Grade. Fruit to be of good quality, reasonably free from blemishes serious for the grade and reasonably uniform in size and degree of ripeness. Sirup, 20 per cent sugar when packed.

Seconds Grade. Trade designation “Seconds.” Fruit to be tolerably free from blemishes serious for the grade and tolerably uniform in size. Sirup, 10 per cent sugar when packed.

Seconds Grade in Water. Trade designation “Water.” Fruit to be tolerably free from blemishes serious for the grade and tolerably uniform in size.

Seconds Grade for Bakery Use. Trade designation “Pie.” Wholesome fruit unsuited for above grades. Minimum drained weight 68 ounces No. 10 can.

Trade designation “Solid Pack Pie.” Minimum drained weight 84 ounces, No. 10 can.

Label Weights, Muscat Grapes

Fancy (Sp. Gr. 1.10): 8Z Short, 8 ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08): 8Z Short, 8 ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Standard (Sp. Gr. 1.06): 8Z Short, 7½ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Seconds: No. 2½, 1 lb. 12 ozs.
Water: No. 2½, 1 lb. 12 ozs.; No. 10, 6 lbs. 8 ozs.
Pie: No. 10, 6 lbs. 10 ozs.
Composition

The composition of the grape as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>American Varieties</th>
<th>European Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Cent</td>
<td>Per Cent</td>
</tr>
<tr>
<td>Waste</td>
<td>22.</td>
<td>3.</td>
</tr>
<tr>
<td>Water</td>
<td>81.9</td>
<td>81.6</td>
</tr>
<tr>
<td>Protein</td>
<td>1.4</td>
<td>8.</td>
</tr>
<tr>
<td>Fat</td>
<td>1.4</td>
<td>4.</td>
</tr>
<tr>
<td>Ash</td>
<td>.45</td>
<td>.46</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>14.9</td>
<td>16.7</td>
</tr>
<tr>
<td>Fiber</td>
<td>.5</td>
<td>5.</td>
</tr>
<tr>
<td>Sugars</td>
<td>1.15</td>
<td>14.9</td>
</tr>
<tr>
<td>Acid as malic.</td>
<td>1.21</td>
<td>.47</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>77.8</td>
<td>73.6</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>355.</td>
<td>335.</td>
</tr>
</tbody>
</table>

Raisins

The handicap to the use of dry and processed raisins during the summer and in warm climates is the fact that they are subject to insect attack and to mold. No form of carton is proof against these invasions. Processed raisins occasionally sour if too moist, and again raisins may dry so that sugar crystals will form. As a solution for these difficulties, it has been proposed that raisins be canned.

The best raisin for canning is the half-cured raisin grape, preferably of a seedless variety. The half-cured raisin has a fine rich flavor which is lost in the dried grape, and cannot be recovered by any amount of manipulation. The Muscat has a distinctive flavor that is particularly appreciated in a raisin.

In the case of half-cured raisins, it is necessary to hand-stem the fruit as the cap stem is so tough that it will not break off in the machine. This adds to the work so that packers are not much interested; nevertheless, it is the best way to get quality.

The raisins are washed under sprays of water to rid them of dust and dirt, and filled directly into cans. The fill is made by weight based on a few trials. The can should be filled nearly full, and sufficient hot water or 15 per cent sirup added to just fill the interspaces. The use of a small amount of liquid aids greatly in sterilizing and nearly all will be absorbed by the raisin. It produces a moist raisin with little free sirup.

The cans are exhausted slowly until the temperature reaches 150° F., or above. The raisin flavor is sensitive to heat so that it is not carried to a higher degree than is necessary. The cook is about 18 minutes for No. 2 cans, and 25 minutes for No. 2½ cans at 190° F. That will suffice to destroy all the yeasts. It is preferable to cool the raisins as it conserves the flavor.

A method of canning prepared raisins commercially is described by W. V. Cruess, in The Canner, July 16, 1932. Fully cured raisins are stemmed and cap stemmed in the usual manner by machines or in the case of newly cured fruit the grapes are prepared for cap stemming at 145° F. instead of 175° F. They are next washed and seeded, if of a seed variety.
In the seeding process the grapes are heated between 200° and 210° for two minutes or more to soften them so that the seed may be forced out. During this operation the fruit takes up some water and additional hot water may be sprinkled on if deemed advisable.

The raisins are filled into 8-, 12-ounce, and No. 2 lacquer-lined cans as a solid pack. No water or sirup is added. Owing to the absence of free liquid, heat penetration is very slow, the rate being determined by many experiments. The object is to have the raisins reach 160° F., or slightly above, for about 20 minutes. As a result the following schedule is recommended:

<table>
<thead>
<tr>
<th>Can</th>
<th>Exhaust Time</th>
<th>Cooking Time, 212° F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ounce</td>
<td>8 minutes</td>
<td>35 minutes</td>
</tr>
<tr>
<td>12 ounce</td>
<td>8 minutes</td>
<td>40 minutes</td>
</tr>
<tr>
<td>No. 2</td>
<td>12 minutes</td>
<td>55 minutes</td>
</tr>
</tbody>
</table>

Other experiments indicated that the raisins might be mixed with sufficient hot water to bring the total moisture up to approximately 33 per cent, the batch mixed, and heated to 170° F. for about 20 minutes, filled into the cans hot, sealed, and that they would keep without any subsequent cooking. It is believed that this could be developed into a continuous process. Where any spoilage occurred in these experiments, it was due to too high water content, and when crystals separated, it was due to too low water content and storage in a very cool place.

The same article states that F. G. Foss, working along a similar line filled the cans with a weighed amount of raisins, according to the moisture content, and then filled the cans full of water, exhausted them, and then filled them to make a uniform fill. He found that an 8-ounce can held 8 1/4 ounces of raisins, plus some water, and that the sealed contents would be about 10 ounces, and for the 12-ounce can the fill was 12 3/4 ounces, and the cut-out 15 ounces. These weights will vary with the moisture content of the raisins. The exhaust was 8 minutes, and the cook 35 minutes for the 8-ounce, and 40 minutes for the 12-ounce can. He also recommends that the cans be rolled while cooling to insure uniform absorption of the liquid by the raisins.

**OLIVES**

*Olea europea, L.*

There is no tree nor fruit which offers more in interest than the olive.* To obtain anything approaching an idea of its many-sidedness, it is necessary to become acquainted with the life and legends of ancient peoples, in which it entered as sustenance and as symbol; to know something of art, as the olive has furnished the motif for much decoration, both symbolic and purely aesthetic; to have some knowledge of botany and horticulture, to appreciate its parts and to understand their structure and development; something of chemistry and physics, to understand its various constituents and their intelligent treatment; something of the culinary art, to understand its value and varied uses as a food and condiment; of medicine, to appreciate the many virtues ascribed to it as a healing agent; and of cosmetics, to believe all that is claimed for it as a cleaner and beautifier. Each

---

phase offers many fascinating possibilities, revealed through the most ancient as well as the recent literature, for with time the olive has gained both in interest and value.

**Origin**

The olive, according to De Candolle, has been cultivated for more than 4,000 years, probably the longest period for any tree with the possible exception of the apple and fig. Its early history is known only through ancient literature and ancient remains in which it served either as decoration or as a constituent. Through these its original home has been traced to Asia Minor, a region originally extending from Syria to Greece. That it grew on Mt. Ararat, and was the harbinger to Noah of the recession of the flood is told in Genesis: “and the dove came in to him in the evening, and lo, in her mouth was an olive leaf pluckt off.”

The ancient Egyptians, as a part of the fruit of their conquests, obtained the olive during the 19th dynasty. Mummies, dating from the 20th to the 26th dynasty, have been found surrounded by garlands of olive leaves. From Egypt it spread into northern Africa. It is said to have been taken to Greece by Cecrops, the founder of Athens. The legend states that a city had been built on the banks of the stream Kephisos, which Zeus foresaw would some day become the noblest city of the earth. There was strife between Poseidon, the lord of the sea, and Athene, the goddess of wisdom, as to whose name the city should be called. It was proclaimed that Zeus had willed that the city should bear the name of the god who should bring forth out of the earth the best gift for the sons of men. After the proclamation was made Poseidon rose and smote the earth with his trident, straightway the earth was shaken and sundered and from a chasm a horse appeared, the like of which had never been seen for strength and beauty. Poseidon said, “Behold my gift, and call the city after my name. Who shall give aught better than the horse to the sons of men?”

Athene said no word but stooped to the ground and planted therein a seed. Presently the gods saw a sprout appear, which grew up and sent out its branches and leaves. It grew higher and higher and with abundant green foliage, and finally put forth fruit. Then Athene said, “My gift is better. O Zeus, than that of Poseidon. The horse which he has given shall bring war and strife and anguish to the children of men; my olive tree is the sign of peace and plenty, of health and strength, and the pledge of happiness and freedom. Shall not then the city be called after my name?”

With one accord the voices of the gods rose in the air, as they cried out: “The gift of Athene is the best which may be given to the sons of men; it is the token that the city shall be greater in peace than in war, and nobler in its freedom than in its power. Let the city be called Athens.”

Pindar says that all the slopes of Olympus were soon covered with it, and that the Athenians used to crown the victors in the Olympian games with its branches. Later it was used to crown their warriors and wise citizens. The method of oil extraction was also obtained from outside. The Greeks are supposed to have had the wild olive, Oleaster, previously, but the fruit of this is valueless. They are the first European people to have cultivated the olive. Its cultivation spread to the surrounding countries,
where the Greeks founded colonies, Sicily, the coast of Italy, and Gaul, these forming nuclei for its spread into the adjacent lands. Pliny states, however, that the olive was not introduced into Italy until 627 B. C., and that it reappeared in Gaul in 600 B. C., being carried to the latter country by the Phenician colony that founded Marseilles.

The olive was carried later by the Romans into the countries in which they settled, Spain being the most notable, but it was also carried into the Iberian peninsula by the Arabs.

The Greeks and the Romans cultivated it on the northern side of the Mediterranean, the Tyrians on the southern side, and the Arabs finding it there carried it with them into Spain when they settled in that country. The double origin of the olive, Greco-Roman and Semitic, in this latter country is borne out by the names bestowed on the olive. In southern Spain the tree is called aceituno, the olive fruit aceituna, and the oil aceite, the name evidently derived from the Arabic name Zeitoun, this in turn being derived from the Hebrew Zeit. In northern Spain both Arabic and Latin names are used, the tree is called olivo or oliveira, whereas the fruit and oil have the Arabic derivative names aceituna and aceite respectively, but the oil used in the church and in painting is called oleno. In Portugal similar conditions prevail, the cultivated olive is called by the Greco-Latin name oliveira, whereas the wild olive is called by the Arabic name Zainhugciro, the fruit a:2eitona, and the oil azeite.

The olive has been given fanciful names by the early peoples. It was known as the “tree of wisdom,” “Minerva’s tree,” the “Gift of Heaven,” etc. The Greeks consecrated the tree to Minerva and made it the symbol of wisdom, abundance, and peace.

Though some botanists claim that the olive is native to the Canary Islands, no word for it is found in the remains of the language of the Guanches, an ancient, but extinct race of people who inhabited the islands. The available records show the tree to have been introduced there since 1403, and probably by the Phenicians.

The olive was introduced by the Spaniards into Chile, Peru, Mexico, and the United States. The statement as generally made is that it was brought by Jesuit missionaries from Mexico into Lower California, the first settlement being at Loreto in 1697. These missions extended northward, and in 1769 one was founded in San Diego, California. The olive was introduced there by the Spanish navigator and explorer Don Joseph de Galvez while in the service of his government. He also planted figs, pomegranates, oranges, citron, and dates at the mission. Father Junipero Serra was a member of the same party, and afterward established the missions extending in a chain along the coast to the north central part of the state, and plantings were made from that stock. It is stated that a number of the original trees are still in existence though time and neglect have exacted a toll of the majority and the same is true for those set out at the other posts. Doubtless the pioneers anticipated that the olive would find the same use here as in their native country, a source of delectable oil for food and also for use in the churches and in certain religious observances. It was a hundred years, however, before there was any attempt at such a realization. In 1872, Frank E. Kimball at San Diego, Elwood Cooper at Santa Barbara, and E. E. Goodrich at San Jose made plantings on a sufficient scale to pro-
duce fruit for oil. In the decade following, a land boom was staged and olive culture was one of the diversifications which were attempted. Few of the large plantings made then or during the next fifteen years developed in accordance with the expectations of the owners. Land wholly unsuited to the purpose was set in trees, likewise varieties used which were not suited to the conditions, with the result usual to such misdirected effort. In recent years the plantings have increased in other localities due to the favor accorded to both the oil and fruit. They have spread around San Diego and Los Angeles, into the San Joaquin Valley, and north into the Sacramento Valley in California, and also into Arizona.

At the present time the olive is cultivated more or less extensively in the countries surrounding the Mediterranean and in the Western Hemisphere in California and in one or two of the countries of South America.

Longevity

The olive tree is of slow growth, but if allowed to grow naturally persists for centuries and attains a great size. De Candolle describes one tree 23 feet in circumference, its age supposed to be over 700 years. Tournefort found fruitful old olive trees between Ephesus and Smyrna which must have been planted before the Musselman invasion, as Turks had not planted olives, not esteeming them. The Mount of Olives on the east side of Jerusalem was among the places best cultivated. Near the foot was the grove called Gethsemane (Gath-Semen, oil press) because of the olives with which it was covered and those of the slopes above where an abundance of oil was pressed out. In the Garden of Gethsemane there remain only eight of these olive trees that are supposed to have existed at the beginning of the Christian era. Chateaubriand, writing in the early part of the nineteenth century of these olive trees, said: "One sees there eight olive trees in extreme decrepitude." An article written by J. D. Whiting, when American Vice-Consul at Jerusalem, had an interesting statement relative to one of these trees: "El Butini, the most famous of the Garden of Gethsemane's eight olive trees, under which the Saviour is supposed to have walked during the night of agony, has recently collapsed. The great tree was weakened by the locust plague during the spring and summer of 1915. When El Butini falls, then falls the Turk, runs the legend."

Throughout Europe and Asia are many old olive trees, some of them producing abundantly, their origin, however, lost in remote centuries. The olive is very tenacious of life, but the methods of cultivation, which tend to increase production, reduce resistance and longevity.

Etymology

The generic name Olea is from the Greek elaia, derived from the Celtic or Gothic olew, oil, on account of the abundance of oil in the fruit. The specific name europaea is given to the species cultivated throughout Europe.

Description

The olive is an evergreen tree about 20 to 30 feet high, much branched and spreading. It forms a symmetrical head, having angular branches and opposite leaves. The leaves are dry and leathery in texture, lanceolate, entire, deep green above, and light hoary beneath. The flowers are small, star-shaped, creamy white with yellow centers, have a faint pleasing odor,
and are axillary in compact racemes. The fruit, a fleshy pendulous drupe, is very abundant. It is oval, obovate, or globular in shape, from about one-half inch to an inch and an eighth in diameter, dull greenish yellow even when full size but unripe, then gradually becomes straw, yellow, red, and finally turns a glossy purplish black or black when ripe. In ripening, the side exposed to the sun reddens, then gradually the whole fruit changes from a red to purple, then black. As fruit of all degrees of ripeness are developed at the same time, the tree furnishes an extremely beautiful combination of colors, the various greens of the leaf and fruits forming a background for the splotches of red, purple, and black formed by the ripening fruit. The fruit is peculiar in two respects: first, in that it contains in addition to the ordinary constituents of fruits an abundance of edible oil, consequently, making it a valuable food; second, in that it contains a bitter substance which does not disappear on maturity, so that the fruit cannot be eaten at any state in its development without preliminary treatment for the elimination of this substance. The stone is two-celled, many times only one seed developing.

**Climatic Requirements**

The olive tree requires a rather warm temperature, light humidity, and absence of heavy frosts. It can withstand temperatures of -7 to -8° C. (17 to 19 F.), or even lower if not too prolonged, and if the change to higher temperature be gradual. Moist cold is more unfavorable than dry. The altitude at which it will grow depends on the local climate. The climate of the countries bordering on the Mediterranean and that of California are particularly favorable.

**Varieties**

The wild olive Oleaster is said to have been the original form, called by Linnaeus *Olea europaea sylvestris*, later by De Candolle *Olea europaea oleaster*, and the cultivated form *Olea europaea sativa*. The reason for this belief is said to be that the oleaster seeds reproduce trees true to type, whereas the seeds of sativa produce trees having the characteristics of oleaster but, though oleaster under cultivation becomes modified in various ways, it does not produce fruit like sativa. Whichever form was the original, the subjection to cultivation for over 4,000 years, under the varying conditions of soil, climate, and methods of cultivation, has produced many varieties. Many of these doubtless are the result of accidental modifications, more or less fixed by successive cultivations. At the present time there are certain well defined varieties which are cultivated, and of which the characteristics are well known, so that varieties may be selected according to the purpose desired, whether for the preservation of the fruit green, half ripe, ripe, or for extraction of oil.

Of the large number of varieties introduced into California, Wickson reports analyses made by the State University on 57 varieties. Of these only a comparatively few were retained as worthy of cultivation, chief among these being the Mission olive, the one originally planted by the padres in the mission gardens. Other varieties which are now being cultivated are the Manzanillo, Ascolano, Sevillano, and Barouni.
Propagation

The olive is propagated by means of seeds, cuttings, grafting, and budding. Propagation by seeds is seldom done in this country, as it is so much slower and more troublesome than by cuttings, aside from the fact that the desired variety may not result. The pulp has to be removed, which is done usually by allowing the fruit to rot or by softening with an alkali. Unless removed from the stone, the seed may not develop for two years, otherwise the seed usually sprouts the first year.

Propagation by cuttings is the commonest and easiest method, as the cuttings root readily, and either old or new wood may be used so that the cuttings may be large or small. Cuttings sent from Europe are usually in the form of truncheons, and these may be cut into pieces like firewood and will root.

The story is told of a grove in Morocco in which the trees exhibited a peculiar arrangement. The reason given for this was that a king and his army on the way to the Sudan had encamped for the night, and stakes or pickets to tie the horses had been cut from a grove near by. The pickets were left and had developed into trees. This seems probable enough when it is considered that pieces of branches are taken, one end whittled to a sharp point and driven into the ground, and that these pieces will take root and develop. An olive company in California a few years ago transferred 3,000 trees, 26 years old, from San Joaquin County to Oroville and Marysville. The trunks were sawed off about 18 inches above the ground, and the roots 12 inches from the stump. In a planting made 6 years previously, the same method was used and resulted successfully.

Where trees are found undesirable for some reason, resort is had to budding or grafting. By these means the undesirable trees are not a complete loss, and results are obtained sooner. Many times varieties are obtained from Europe which upon developing are not found suited to the conditions in this country; these plants may be used as stock for desirable varieties or some desirable variety is obtained which may be propagated rapidly by these means.

The pruning must be done by persons of understanding, as the fruit is borne only on the two-year portion of the branches, and provision must be made to cut excessive growth in the season of too heavy development and stimulate in the season of poor development. The pruning thus regulates the growth of the branches which two years later will control the production of the fruit. Pruning of very large branches is sometimes done to admit more light and heat to the darker and cooler parts of the tree. The work is done in late winter and early spring, but not from March to October, during which period the trees are carefully tended through cultivation, irrigation, and fertilization.

In California the young stock is set out in groves in April, about 35 feet apart. During the non-bearing period, the land between is kept in good cultivation and free from weeds, and often utilized for other crops.

Though numerous stories are written of the remarkable ability of the olive tree to grow and bear in exposed situations, and with only small amounts of soil and water, the olive, like all other fruit trees, requires both cultivation and an adequate amount of water if a constant and abundant harvest be desired. Where the groves are irrigated, the proper amount of
water may be supplied at all times. The water is conducted through a system of underground pipes, which are provided with outlets at the end of each row of trees. From these outlets the water is directed into furrows to water the trees. This system permits the groves to be easily cultivated.

**Products**

It would seem that the olive is rightly and appropriately called the “Tree of Abundance,” for all parts of it have been used, and to the ancients, even with their limited cuisine as compared with that of today, it was a symbol of plenty, as witness the apostrophe of King Sennacherib, made centuries before the Christian era, who called Assyria “A land of corn and wine; a land of bread and vineyards; a land of oil, olives and honey.”

**Flowers:** In ancient medicine the blossoms of the olive were highly esteemed, but are not mentioned in the pharmacy of today. They were used as poultices to alleviate pain, sometimes alone, sometimes mixed with other substances.

**Leaves:** The leaves were also used as medicine, a decoction made from them being said to stop bleeding, and on account of their astringency, to reduce inflammation. The leaves and bark have an acrid and bitter taste, and have been prescribed as substitutes for cinchona. In France an extract of the leaves is used as a febrifuge, and has also been found valuable in preventing hectic paroxysms.

From time immemorial the leaf and branch have been employed as a symbol of peace, and have appeared in sculpture and painting. No more beautiful emblem than the olive branch can be selected or devised to symbolize both peace and victory, and as such it has been known through all the ages. Egyptian mummies, dating from the 20th to the 26th dynasty, have been found surrounded by garlands of olive leaves, and the tomb of the hero of today will oftentimes have its sculptured olive branch, telling its story and making its appeal stronger than could be made by words.

Besides serving for esthetic purposes, the leaves, in spite of their astringency, are eaten by animals as forage, so that the trees have to be protected from them. It is curious that with all the ravages made by animals on the olive trees in the neglected mission gardens in California, after the missionaries had gone, some of these trees furnished scions for many of the olive groves of today.

**Wood:** The wood of the olive tree is much prized for certain purposes. It is very close, fine-grained, yellow to yellowish brown with irregular wavy brown to black lines and mottlings, especially near the root. It has no distinguishable annual rings or pith rays, and has small evenly distributed vessels. It takes a beautiful polish. At present it is employed chiefly in lathe-work and carving for small, fancy articles and for cabinet work.

In ancient times it seems to have had a much wider application due, no doubt, to the size of the trees, which were larger as a result of not being subjected to the rigorous cultivation and pruning which they receive today. The Bible states that olive wood was used in the Temple. In the time of Pliny it furnished material for construction of ships, for wagon spokes, wedges, columns, pedestals, statues, and furniture. The Romans used both the wild and cultivated trees. The wood industry was developed in the vicinity of Nice in both France and Italy, and still flourishes. A consider-
able amount has been exported to England in recent years for the manufacture of walking sticks. The poorer quality is used for firewood, is in-flammable, and produces great heat.

Bark: The bark contains a large amount of tannin. For medicinal purposes it is reduced to powder and acts as an astringent, a tonic, and a febrifuge. In warm climates a resin is exuded from it which solidifies in the air. It is called Lecca gum, as it was first found near Lecca. It contains some benzoic acid among other constituents, and in ancient times was prescribed in medicine, but is not at present, and the gum is considered valueless.

Fruit: The fruit differs from nearly all others in being rich in oil, which has a distinct and pleasing flavor, also in that it contains a bitter principle so that it cannot be eaten directly from the tree. Its great value has been in the oil, which was expressed, and secondary, as a food or relish after the fruit had been appropriately treated.

Fats are an essential in the dietary, and during many centuries the olive was the most important source of supply for the people of southern Europe, western Asia, and northern Africa bordering upon the Mediterranean. They used the oil for both the preparation of dishes by frying or sauteing, as an ingredient, and in sauces. Animal fats were limited; dairying, especially butter-making, was practically unknown in the dry countries, and the preparation of oil from seeds and nuts was little understood. It is not surprising then that the olive was regarded as indispensable, that an abundance of oil was looked upon as a blessing from God, and that its storage and use in commerce was regulated to serve as a reserve in lean years. Outside the area indicated, however, the use of olive oil as food or of the olives was of comparatively little moment until within the past two centuries. Prior to that time it was a foreign luxury. Reference is first made to the use of the oil in “Ancient Cookery,” an English manuscript of 1381, and to the fruit by L. Lemery in “Traite des Aliments,” 1705. The oil which was exported was largely for medicinal and sacramental purposes rather than as an aliment. Then the inevitable happened; many sources of oils and fats were found of equal nutritive value to that of the olive so that one has a choice based upon cost, personal preference, or convenience.

It is more difficult to make a correct appraisal of the fruit with relation to other foods. It has been considered choice at all times. It has appeared at the feasts of epicures, both ancient and modern, as a relish, and to be eaten at the end of the repast as part of the dessert, and it has also furnished a staple food for the poor in the Orient and in Greek and Latin countries. Those who were well provided were admonished to have care for those less fortunate: “When thou beatest thine olive tree, thou shalt not go over the boughs again; it shall be for the stranger, for the fatherless, and for the widow.” (Deuteronomy XXIV, 20.) The people obliged to live frugally have found it a great resource, particularly in Lent and for those at a distance from the sea unable to obtain fresh fish. It is said that Plato preferred olives to all other foods, and often made a meal on them alone.

Though olives are known and consumed throughout the civilized world, comparatively few persons, aside from those living in the regions of their cultivation, know that olives have to undergo certain treatment before they can be eaten. It is a familiar trick in olive regions to encourage the visitor
to taste the fruit directly from the tree. The fruit, both green and black, looks so fine and tempting, that the disgust on tasting is correspondingly great. It is claimed that some of the older varieties could be eaten without preparation, that they dried naturally and were sweet. From many recipes of ancient food preparations, one may justly infer that some of the natural flavor of the olive may not have seemed objectionable as at present.

The olive contains a substance or substances which must be removed before the olives are edible. It is referred to in most of the literature as a "bitter principle," and has been called an acid, a tannin, and more recently a glucoside. Cruess has repeated the work of the various investigators, who claimed these different substances, and as a result has come to the conclusion that it is a glucoside; that is, a combination of glucose with another compound.

In immature fleshy fruits there is usually an accumulation of acids, tannins, and sometimes starch. As ripening proceeds, carbohydrates and aromatic substances are formed, and the bitter, acrid, or astringent taste disappears. In the olive there is no starch found at any stage of maturity. Glucose has been found in all stages, and is supposed to be the substance from which the oil is formed. The oil is in very minute quantities in the fruit up to the time when the pit is formed, from then on it increases gradually up to its maximum when the fruit is not quite mature. In the plant economy, the fat or oil is one of the most important food reserves of plants. All parts of the fruit—rind, flesh, stone, and seed—contain oil, the fleshy part forming about 80 per cent of the fruit containing the largest amount.

Contrary to the conditions existing in most fruits, the bitterness remains through all stages of development in the olive. A substance of glucosidic nature, given the name "oleuropeine," has been isolated and found to be of extreme bitterness. This may be the substance or one of the substances which cause the inedibility of the untreated olive.

Composition

The composition of the olive differs from the ordinary fruits in having a higher percentage of solids and particularly in the high fat content. The figures, as taken from "Foods: their Origin, Composition, and Manufacture," by William Tibbles (1912), are as follows:

<table>
<thead>
<tr>
<th>COMPOSITION OF PICKLED OLIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Refuse</strong></td>
</tr>
<tr>
<td>Green:</td>
</tr>
<tr>
<td>As purchased</td>
</tr>
<tr>
<td>Edible portion</td>
</tr>
<tr>
<td>Ripe:</td>
</tr>
<tr>
<td>As purchased</td>
</tr>
<tr>
<td>Edible portion</td>
</tr>
<tr>
<td>&quot;Mission&quot;:</td>
</tr>
<tr>
<td>As purchased</td>
</tr>
<tr>
<td>Edible portion</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>

The flesh of the American ripe olive consists of about 80 per cent of the fruit, and of this the solids average 38 per cent, oil 25 per cent, and protein
1.2 per cent. This gives it a very high nutritive value and particularly useful to adherents of a vegetable diet. In this country the olive is primarily a condimental food and as such there is not a great deal of difference between the green and ripe fruit other than the taste which is developed by the method of treatment. The flesh of the green olive is generally firmer, more adherent to the pit, and has a salty, acid taste. The flesh of the ripe olive is more tender, loosens from the pit, and has a bland, oily taste.

Preparatory Operations

Since the canning of the ripe olive has been developed as a means of preserving the ripe olive after it has once been treated to remove the bitterness, it is desirable to follow the development of the preparatory treatment even though it includes the pickling process as applied to both the green and ripe fruit.

A means for treating olives to make them not only edible but much esteemed must have been learned in very olden time. While the primary use of the fruit was for oil, it was also eaten. As already indicated, some varieties were described as edible and possibly people were more tolerant of the acridity. It is evident, however, that at an early date olives were soaked in water which was changed from time to time in order to withdraw the bitterness. Sometimes warm or hot water was used in this process. The olives, after being treated, were held in brine. As far as known, no other fruit or vegetable had been treated in a similar manner and it is therefore reasonable to conclude that this was the forerunner of all salt curing or pickling of fruits and vegetables, if not of all pickled foods.

Another treatment, which if not coincident with the soaking process is nearly as old, is to mix the olives with coarse, dry, sea salt, sometimes described as mixed with roasted sea salt. The salt and olives were mixed together until the salt abstracted a brownish liquid and the olives became shrunkin and tough. At the finish the olives might be placed in fresh salt with some water. A variation was to place the olives in water first for sufficient time to at least partially remove the bitterness, and then pack them in the dry salt to complete the work. Green as well as ripe olives were treated, but the ripe were preferred.

These methods, soaking in water and packing in dry salt, were practiced prior to the Christian Era. Cato (234 to 149 B. C.) states that the round and the bitter keep best in brine, but if bruised, to put in mastich oil. Round olives retain their black color if packed in salt for five days, then the salt brushed off, and the olives exposed to the sun for two days, or they may be preserved in must boiled down to one-third and without any salt. So it is of interest to find a recent patent granted as a new process of curing olives which so closely approaches the old. The descriptive paragraph will be quoted from Patent No. 1,211,844, issued January 9, 1917, to F. P. Herbert, San Francisco, California.

The preferred form of my process and applicable particularly to the preparation of the California ripe olives for marketing is described as follows: I first place the fruit in crates, or baskets, or vats, or other suitable receptacle, and preferably provided with means of ventilation and drainage, in combination with coarse or granular or rock salt. This is continued until the olive takes up the requisite salt after which the superfluous salt is removed. This may be done by removing the olives to a table, or screen bottom tray, or other suitable holder, and the salt removed by gentle agitation, or blowing, or suction, or a simple brushing or wiping of the surface or any other suit-
able means may be employed. The olives are now placed in closed containers, which may be suitable for shipping, with the proper quantity of fresh salt, preferably a finer grade; and shortly thereafter a small amount of brine or water is added. During this period and before shipment they are turned or moved from time to time to secure the exposure of the entire mass to the saturated solution of salt and are now ready for marketing.

The Romans exercised the greatest care in their preparation and introduced refinements in not only removing the bitterness, but also causing them to acquire various flavors through infusion in solutions containing aromatic substances.

One of their methods for the preparation of green olives consisted in adding roasted salt to the olives after a preliminary soaking in hot water, then covering them with grape must, boiled wine, or honey water, and to this solution were added fennel, mint, and lentiscus seed. Fennel was used as a tampon to keep the olives immersed. A simpler method was to use vinegar with the brine. Sometimes the olives were beaten to facilitate the action, but this caused discoloration, which was avoided by making cuts in them. The brine was replaced by oil as a preserving liquid. Another method was to put the olives with the aromatics in the brine at the start, then they were removed, crushed lightly, and put in a mixture of oil, vinegar, and honey, to which were added leek, celery, mint, and sometimes rue. The rue was supposed to be most efficacious in bringing out the natural flavor, and was most prized. The mature olives were first put in brine for 30 to 40 days, then in the preserving liquid with the aromatics. Olives prepared in the ways indicated were known as "Colymbades."

A form of conserve made by the ancients, and to which the name "Epi- tyrum" was given, consisted in taking green, mature, or black fruit, though, as in the former, the green were preferred, and drying them in the shade, after which they were put in baskets and crushed in a press. The crushed fruit was then put in vessels, sprinkled with salt, and had mixed with it lentiscus seed and minced leaves of fennel and rue, and was finally covered with oil.

Many directions have been left by the Romans relative to the olive. Columella, a writer on agriculture who flourished about 45 A. D., wrote in detail on the cultivation, harvesting, extraction of oil, and the preservation of the fruit. His directions for the treatment of the fruit do not differ essentially in the principles employed from those of today. They were to use six pounds of quicklime, broken very small and dissolved in water, to which twelve pounds of oak ashes and water in proportion were added. This amount was sufficient for twenty-five pounds of olives, which were soaked in it for eight to ten hours; they were then taken out, washed carefully, and immersed for eight days in very clear soft water, which was changed several times. An aromatic brine was prepared by infusing some fennel stems in hot water, the stems were then removed and salt added in sufficient amount to float an egg, and on cooling, the olives were placed in it.

The recipes of PallADIUS (1518-1580) show that the Romans used lye solutions though this is supposed to be a modern practice.

In the recipe of Columella, sifted ashes are indicated as one of the ingredients, and it is supposed that this recipe, changed in detail, furnished the basis for present day methods. The use of wood ashes as one ingredient in the preparatory treatment was introduced into France by two Italian
refugees, Antoine and Amant Pichiliny, who settled in Provence, about 1750, devoting themselves to the preparation and sale of preserved olives. The olives preserved according to their process are called "Olives a la Picholine." They made their solution by using one part quicklime and six parts of sifted wood ashes, onto which they poured water which was allowed to slowly drain away. One statement is that straw or a straw mat was placed on the bottom of a tall cask, the mixture of lime and ashes put on it, and the resulting lye drawn off and used on the olives. The lye was applied for six hours, then the olives taken out and placed in fresh water where they were kept for nine days, the water being changed daily. At the end of this time they were taken out and thrown into brine made sufficiently strong with salt and in which aromatic herbs had been infused. This was the most important method used during two and a half centuries. So appreciative were the people that one of the varieties of the olive was named Picholine. Previous to their time the preparation in southern France consisted of crushing the olives lightly, immersing in clear water, which was renewed each day for about nine days, then preserving in brine. This latter process is still employed for the olives in which appearance is not an asset. For the more carefully prepared ones, the method was to pick by hand when the olives had attained full development, then to sort carefully and immerse in lye, the duration in the lye depending on its concentration and the size of the fruit. They were removed from the lye when the flesh was penetrated to, and readily detached from, the stone.

There are many variations of the lye treatment. In the olive countries the preparation is done in the homes as well as in factories, and it is in the homes, naturally, that the greatest variations occur. Lime is often used with the ashes, one formula consisting of the olives mixed with a paste of wood ashes and freshly slaked lime. In the ordinary methods, however, a solution is made of the sifted ashes and lime, sometimes sodium carbonate taking the place of the ashes. In the ordinary factory preparations both ashes and lime are omitted and either caustic soda or potash used. When removed from the lye, the olives are put in clear water, changed night and morning for several days, then put in brine.

The early accounts of olive preparation show quite conclusively that great variation in strength of the caustic solution was inevitable, but the tendency to err was on the weaker side. It was not until the modern introduction of caustic preparations of soda and potash that standardization of the process was possible. Even with this possibility the practice remains largely empirical and is based upon the experience of the operator. Some operators still adhere to the use of weak solutions, taking considerable time to act upon the olives, whereas others use relatively strong solutions so as to hasten the process.

The brine used has been subject to quite as marked variation as the lye. A weak brine has been used in order to encourage the natural fermentation of the fruit, which corresponds to the fermentation in cucumber pickles. The other extreme is represented by the use of very strong brine which practically inhibits all fermentive change and the same brine filtered and used a succeeding season. Every gradation between these extremes has been in common use. As might be expected, more or less of the fruit softened and underwent changes which at present would be regarded as decomposition or rotting rather than as clean, normal fermentation. The
esthetic side of olive preparation has not always been of the highest order, though, as in the case of many other foods, very great improvement has been wrought in recent years.

Even with the later methods the use of aromatic substances has not been abandoned, and many of these are used, such as bay leaves, cloves, coriander, cumin, mint, orange skin, fennel, etc., the amounts and combinations varying greatly. Sometimes aromatics are first extracted, the solution concentrated, and a quantity of this solution added to the brine, or the aromatics are boiled in brine at the start, then removed, and when the brine is cooled, it is ready for use.

In Spain the ripe olives are not treated ordinarily with lye, but by the slower process of soaking in water. The black olives, gathered late in the year, are cured in a salt brine to which black pepper is added. After the bitterness is removed, they are preserved in oil.

A process used at present for ripe olives which is very simple but effective is to mix fine salt with them after they have been cleaned and sorted. They are stirred twice a day, and through the osmotic action of the salt, a dark colored juice is exuded, which contains among other constituents, the substance causing the bitterness. To hasten the action, the olives are pierced with a needle. The Spaniards vary this method by adding aromatics, as wild marjoram, thyme, fennel seed, anise seed, garlic, laurel leaves, etc., at the same time as the salt. The special spice mixtures are held as trade secrets by the manufacturers. When the bitterness has been removed, the olives are washed, dried lightly, and placed in casks or jars until required. Before being served, the olives are soaked in oil.

One style of Greek packing of ripe olives is of special excellence. Sour wine is added to the pickle to accentuate the flavor, and the product packed in oil. The olives are plump, tender, and brilliant, and possess a rich flavor.

In parts of southern Europe certain kinds of olives are left on the trees to become very ripe, and are then dried in the sun without any preparation. These are only used locally as they are lacking in the fine flavor of the prepared olive.

At present the use of aromatic substances commercially is not large. It is contended that consumers cannot use flavored olives in sauces or other preparations so freely, as extraneous flavors are introduced which in some cases are undesirable, the unflavored olive permitting greater freedom in use.

For the preparation of the green olives "a la Sevillane," the fruit is first treated with alkali, then washed in clear water, after which it is put into 2 or 3 per cent boiled brine, where after a time fermentation starts, which imparts a slight lactic acid taste to the fruit. It is then washed in water, graded for size, and put in barrels with a 5 or 6 per cent salt, when they are ready for consumption.

The half-ripe olives are put in a brine previously boiled of 12 to 15 per cent for six days, after which they are washed in running water and then put in jars in a 6 to 8 per cent brine with a bay leaf and a sprig of thyme and fennel. Olives prepared in this way are called "a la Provençale." A variation on this method, called "a la madriline," is to put the olives in barrels, after the preliminary salting and washing, in 10 per cent brine with red pimiento, pepper corns, laurel, thyme, and tomato purée.
The black olives are gathered at the time of the change in color, and put in water, renewed every 12 hours, until the bitterness has disappeared, which requires 40 to 50 days, sometimes even longer. They are then put into brine.

The large olive “La Tanche,” after sorting and cleaning, is put directly into a 10 to 15 per cent brine in wooden casks or cement tanks which hold from 4,000 to 6,000 kilos. When the bitterness has been abstracted, they are ready for sale. The brine is decanted and held until the following year.

To prepare them so that they may be ready for sale sooner, the fruit is run over a roller provided with fine points which perforate the skin, after which the olives are put in layers and sprinkled generously with salt. They are stirred frequently, and when they “sweat,” are put in barrels with pepper corns and bay leaves, or in jars with olive oil and condiments, or they may be put in jars without any addition as they are preserved by their own oil and absorbed salt.

In the preparation of the olive, both green and ripe, during all these centuries, there was no attempt at sterilization. The preservation depended upon partial drying, to the action of salt, and to the spontaneous fermentation in pickle in which certain desirable forms of organisms had the ascendancy. This fermentation took place after the lye treatment due to organisms which were upon the fruit and survived the treatment, or it might be induced with a starter from old brine or from a good active fermentation. It was considered as normal to the olive as the fermentation of the grape juice is in making wine. It converted an indifferent morsel into one that was tart and a delight to the sense of taste. It is this quality which makes the green olive at present one of the outstanding condiments or relishes. With the fruit thus prepared under such varying conditions of manipulation and storage, under limited control at best and no control in most cases, there must have been considerable quantities which spoiled, and yet no illness is known to have resulted. The fermentation process was the factor of safety as in the case of other pickled fruits and vegetables, or at least such seems to have been the case.

Imported Green Olives

Nearly all the imported green olives used in this country come from Spain and are generally known as “Queen olives.” In years of shortage a few come from Italy, Greece, and France. They are hand-picked, cleaned, treated in the usual way with lye, and washed, but during this process care is exercised to prevent them being exposed to the air in order to retain the green color. They are then graded for size and quality and placed in huge casks or “pipes” with sufficient brine to cover them. The “pipes” are exposed to the sun to favor the fermentation which requires six weeks or more, depending upon the temperature. During the fermentation, the olives change slowly from a deep green to golden. The pipes hold from 160 to 180 gallons and are used for shipping the olives. Ten per cent brine is used for filling the casks, but the brine weakens as the salt is taken up by the fruit during the curing and is usually 7 to 7½ per cent at the finish. Before shipping to this country, it is often reenforced to make from 8 to 9 per cent, but higher amounts make the olives excessively salty. The acidity varies considerably, but in firm, crisp stock it is generally above .6 per cent.
The Queen olives are hand graded for size on the basis of the number per kilo. The following grades are made: 60-70; 70-80; 80-90; 90-100; 100-110; 110-120; 120-130; 130-140; 140-150; 150-160; 160-180; 180-200; 200-220.

They are also graded for quality, as: “Prime” or “first quality,” “seconds,” and “Queen Culls.” Only the first and second grades are sent to this country though all sizes are, but there is no designation by which the consumer may obtain a desired size. The term “Queen olive” may mean those having 60 to the kilo or those with 220 to the kilo.

Some green olives are packed in tins and shipped to this country, and a comparatively few are brought in bottles. The importers prefer to purchase the olives in bulk and pack according to their trade requirements. The olives are transferred from the pipes to bottles and either supplied with fresh brine or the brine from the pipe is carefully filtered and only such addition made as needed to make up the difference. The use of the original liquor gives a decidedly better flavor, though it is often sacrificed in order to get one which is perfectly clear. If olives are not completely cured when taken from the pipe and placed in glass jars, or if the brine be made too weak, organisms may produce a film on the surface of the liquid, cloudiness of the liquid, or a dulling of the surface of the olive. These organisms may be either bacteria or a type of yeast. The use of very hard water may cause a deposit of very finely divided lime salts and produce the same general effect.

The green olive is retailed almost wholly in glass, either in fancy hand-packed packages or in pint and quart jars. Many attempts have been made to create a sale in tin containers, but without success as there are decided advantages in being able to see the size and quality. Seeing the fruit, no doubt, frequently suggests its use and purchase. A few olives are still retailed in bulk, but they soon become covered with yeast and other organisms, and have an unattractive appearance. Foreign green olives packed in tin are not sterilized by heat but depend upon the lactic acid content for preservation. The cans swell and while the contents are not spoiled, the goods are no longer merchantable as the public has been educated to regard any swelled can as unfit for use.

The origin of the stuffed olive is of very recent date, but by whom originated is not quite clear. According to H. C. Newcomb, former vice-consul to Spain, stuffed olives were unknown before 1893-4. It was in 1895 that Señor Picasa, the general manager of the Sevilla Packing Company, had seen olives stuffed with pimientoes in Spain, and in the following year introduced them into the United States, the company packing them under the copyrighted name of “Pimola.” In 1897, a Spanish house packed pepper-stuffed olives, and later on other firms also, among the latter many American firms. As the pimiento is grown and prepared in Spain, and labor cheaper there than here, the industry has been practically transferred to that country.

The operation of stuffing consists in removing the pit and filling the cavity with some other substance, particularly pimiento, these forming the bulk of the stuffed olive trade. The bright red of the latter gives a pleasing contrast with the green, and the mild pungency is very agreeable to many persons. Pickled celery, capers, etc., have been used, but were not
so favorably received, and at present, the substances used to any extent, aside from the pimiento, are Manzanillos stuffed with pieces of Queens, and some stuffed with anchovies for the South American trade. Pitting machines have been devised, and also machines for stuffing the olives, but the work done by the stuffing machines is crude as compared with hand work. The olives used for stuffing are the Manzanillo which are smaller than the Queen. The sizes are as follows: 180-200; 200-220; 220-240; 240-260; 260-280; 280-300; 300-320; 320-340, and 340-360.

They are packed in barrels of about 45 gallons capacity, and, like the Queen, are repacked into individual containers in this country.

A few olives are packed with a mince of capers, anchovies, truffles, etc., and the olives preserved in oil. A few are packed for garnishing, in which cubes are cut out and the spaces filled with bright peppers.

Canning

The canning of olives is the American contribution to the conservation of the fruit, one made necessary in order to find a market for the product coming from the new groves which were reaching bearing age. The first crops were pressed for oil, that being the article most familiar in trade, but the industry made little progress while at the same time the imports of foreign oil constantly increased. Lack of experience in its preparation and crude equipment proved such handicaps that most of the olives were not even harvested in the nineties. A few olives were pickled according to the best understanding of European methods but they could not be held long nor shipped to the eastern markets. It was while working upon a spoilage problem in pickling in 1889 that Prof. Bioletti of the University of California came to the conclusion that the spoilage of the prepared olive could be prevented by canning in accordance with the methods used for fruits. Credit for the development of a successful technique for canning is generally given to Mrs. Freda Ehmann of Oroville, in 1903. W. V. Cruess, in an article in The Canner, July 30, 1927, gives credit to C. W. Gifford of San Diego, as putting up the first commercial pack in 1901. Whichever be correct, it was the beginning of the olive industry in the state. A slow but healthy growth was made each year until the pack amounted to 400,000 cases in 1919, then there was a setback to 150,000 cases the next year which took until 1926 to make a recovery, and since which time the pack has grown to 800,000 cases annually. (816,222 cases, 1931.)

From the beginning of the packing of olives in jars and cans until 1920, the methods of preparation were held as nearly secret as possible. Each factory modified or developed some detail in the operation with the result that there was considerable variation in both the methods followed and in the resulting product. Individual experience was the only guide and as the results were frequently unsatisfactory, the industry in time was forced to organize and employ scientific research to determine the proper methods and their limitations. Most of this work has been done under the direction of Prof. Cruess at the State Agricultural Experiment Station with the result that certain basic principles have been determined so that in the future losses may be averted and further improvement over present methods be made along rational lines. Instead of broad, general statements
which are too indefinite to be followed, the characteristics of the different varieties of olives have been made known and also the differences which must be observed in treating them. Salt and lye are looked upon as physical and chemical agents producing certain changes by osmosis or through certain reactions which are measurable and which are influenced by the temperature. The role of micro-organisms in producing both desirable and undesirable changes has been determined and, consequently, the means for their control. Most of the facts have been published and others presented at meetings of the technical men concerned with the industry, and since the work has been in progress over a period of fifteen years it is reasonable to assume that the methods have become fairly well standardized.

Varieties Used

Not all olives are suitable for canning, so that experience has eliminated practically all but five varieties. The Mission, the first to be introduced, remains preeminent in point of healthfulness of the tree, in productivity, quality of the fruit, and suitability for the canning process. Its principal defect is the size, the average being less than twelve-sixteenths of an inch in diameter.

The Ascolano is an Italian variety of large size, used abroad for pickling green, but which has been found to be suitable for canning though some slight modifications in manipulation are necessary. It affords one source for olives of large size and the trade is being cultivated to give preference to appearance rather than to the edible quality.

The Sevillano and Manzanillo are Spanish varieties, the former being a very large type used for Queen green olives in Spain, and the Manzanillo, a smaller olive but slightly larger than the Mission. At first it was thought that the Sevillano could not be used, but it has been found that it can be handled satisfactorily, and so furnishes a source for the large size olive that is wanted. The Manzanillo ranks second to the Mission at present. The Barouni, also an olive of large size, is the most recent importation that promises to conform to this style of preparation.

Harvesting

The harvesting of the olive begins the latter part of September or the early part of October, and continues until well into December, the final picking being usually determined by actual or threatened frost. The olive is a fruit which matures slowly so that the packing season is reasonably long, much longer than for most deciduous fruits. One may often see every stage of development from light green, green, straw, yellow, reddish, red, and black on the same tree at one time. The fruit is called ripe when it is at the beginning of the turning stage, though this in reality is a misnomer. Neither does the color have any fixed relation to the oil content as shown by analyses of the same variety of olive from the same locality and in the same season. The flesh of the green olive contained 23.35 per cent; yellowish green, 20.37 per cent; red, 27.35 per cent; and purple to black, 24.89 per cent oil, according to analyses of the Bureau of Chemistry. The packers have agreed upon the following as specifications indicative of the proper state of maturity to be called ripe olives:

Mission Variety: When of a straw color to not more than red all over.
Manzanillo Variety: When not more than half light red.
Sevillano Variety: When not more than half red.
Ascotano Variety: When of straw color and not more than a small blush of color.
Barouni Variety: When of a straw color.
Any variety of olive shall be considered green if it will not yield milk under moderate pressure between the thumb and finger, and shall not be classed as a ripe olive.

**Disqualification**

Olives damaged from any of the following causes are not suitable for pickling purposes:
1. Shrivelled—from any cause.
2. Fruit injured by cold weather.
3. Windfalls, bruised or spongy fruit.
4. Fruit that is diseased or damaged by parasites.
5. Any other condition that makes the fruit unsuitable for pickling purposes.

During the season of 1930-1931, G. A. Pitman of the University of California made a comprehensive examination of the olive to determine the relation of appearance to maturity. His studies included the five principal varieties used in canning as collected in the four different growing districts. A summarized tabulation is as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Green</th>
<th>Straw</th>
<th>Pink</th>
<th>Cherry</th>
<th>Red</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascolano</td>
<td>13.19</td>
<td>15.62</td>
<td>15.82</td>
<td>19.28</td>
<td>19.00</td>
<td></td>
</tr>
<tr>
<td>Barouni</td>
<td>14.23</td>
<td>16.84</td>
<td>18.26</td>
<td>23.60</td>
<td>22.12</td>
<td></td>
</tr>
<tr>
<td>Mission</td>
<td>16.65</td>
<td>20.53</td>
<td>20.91</td>
<td>21.45</td>
<td>24.46</td>
<td>22.75</td>
</tr>
<tr>
<td>Manzanillo</td>
<td>14.70</td>
<td>16.25</td>
<td>17.43</td>
<td>17.47</td>
<td>18.29</td>
<td>18.40</td>
</tr>
</tbody>
</table>

These figures would seem to indicate that a pink color is more properly the mark of beginning of maturity or ripening.

Olives mature slowly and therefore irregularly so that those on the sunny side and those exposed on a tree become more advanced than those on the shady side or in the interior. Olives which are too ripe will not stand the handling and sterilization without injury to the appearance. If too green the oil content is not developed to the maximum, the tissues remain adherent to the pit, they become more or less woody in curing and lacking in the nutty flavor. It follows that the best results can be obtained only by picking at intervals and taking only the fruit in prime condition. That generally means going over the trees three or more times. Such frequent picking results in slow work and loss in time in handling ladders, etc., so that as a compromise most trees probably get but two pickings. The initial costs in the orchard are lessened in this way, but there are other factors which may offset the apparent saving. The extra cost of picking at the proper time results in uniformity and a better quality in the product, in a greater percentage of olives from one to two sizes larger, in a lessened cost on the inspection belt, and a lesser discard from softening and injury from pulling the stems from the fruit since the workmen cannot resort to
stripping. There are no data available to show how one set of conditions may counterbalance the other in the final costs.

The picking of olives is almost a matter of taking each individual fruit so that it is necessarily slow work. Grabbing a handful or using the fingers as a comb, aside from taking unevenly matured fruit, leaves, and trash, results in damage which shows up on the inspection table after the fruit has been prepared ready for the can. While the olive seems much harder than most fruits, it is easily bruised and such spots become more prominent as the preparation nears completion.

The olives are deposited in canvas or grain bags hung from the shoulder or in baskets and poured into clean lug boxes for transportation to the factory or holding station. The lug boxes are ordinarily filled with from 25 to 35 pounds instead of 40 pounds or more as in the case of other fruit. A good picker will gather from 400 to 600 pounds of fruit per day.

Packing the fruit in barrels with a weak brine was believed at one time to be necessary in order to haul the olives to the factory or when shipped by train if they had to be transported for several miles. That method of protecting the olive involves heavy cooperage costs and a large increase in the costs of hauling by truck or freight. Part of the cost is in the package and part in the increased weight. It has been found, however, that with speed trucks equipped with balloon tires there is little injury from hauling in lug boxes, and that it is more economical to collect frequently at the orchards and get the fruit to the factory than to wait for full loads. The barrel system is used to some extent for handling the crop from orchards which are not easily accessible or not near a public highway.

The brine used in this system is most often a 5 per cent solution, which will check but not suppress growth of many organisms. It suffices for a few days but the strength of the brine is raised as soon as the olives arrive at the factory. The olives are watched in the barrel, and, if necessary, the brine is raised to about 7 per cent salt.

In case the olives are hauled directly from the orchard to the factory, the first operation is to run the olives over a cleaner to remove any leaves, twigs, or other foreign matter. While the fruit is on the belt any which may be injured or unfit for any reason are taken out and thus unnecessary handling in subsequent operations avoided.

The fruit is next graded for size for the purpose of securing uniformity in the treatment by the lye and salt. If olives of mixed sizes be acted upon by either lye or salt, considerable difference in time will be required to penetrate to the pit, and while this is not of much importance with the brine, it is in the lye treatment. Mixed sizes result in some being overdone and others being under-treated. The same openings are used in the grader as for the final product even though the work is repeated after the processing.

**Grading**

There are several different styles of machines used for grading for size, some patented, others not. They were the first pieces of apparatus especially devised for the handling of this product. The V trough set on an incline with a belt and fingers above to draw the olive along gently is one of the earliest. The trough is cut out by increments of one-sixteenth of an inch and when the olive arrives at the proper section it drops through. Another
means to produce the same effect is by rollers in pairs with sections cut out to increase the distance between by one-sixteenth of an inch, mounted on an incline. Since the rolls turn away from each other, no injury results to the olive. Another form consists in tube belts mounted in pairs but made to diverge as they pass from the feed end. The olive rides on the pair of tubes and falls between when the spread becomes wide enough. The olive not being a sphere does not grade perfectly but close enough for practical purposes.

The size of the openings is as follows: Small, 10/16; Medium, 11/16; Large, 12/16; Extra Large, 13/16; Mammoth, 13.5/16; Giant, 14/16; Jumbo, 15/16; and Colossal, 16/16 of an inch in width or diameter in case a screen is used.

**Lye Treatment**

Two procedures are now open, in one the olives are placed in tanks and treated with lye, in the other the olives are held in a salt solution and treated with lye at a later time.

It is in this phase of the treatment that the fruit differs from all others and wherein an olive packing plant differs from other canneries. The holding and treating rooms are large, equipped with many tanks capable of holding from 750 to 1,000 pounds each of olives and sufficient solution to cover. These tanks are most often of cement, about 3 feet in width, 10 feet in length, and 2 feet in depth. If of wood, they are more often circular, about 6 feet in diameter and 2½ feet in depth. The floor in the room is of concrete, pitched, and guttered to be flushed clean and to carry off lye or brine very quickly. Pipes are also distributed for carrying water, brine, lye, and air so that the contents of each tank can be manipulated as desired and with the minimum of labor. One of the very large curing sheds has 1,000 tanks with a capacity for handling 500 tons of fruit. Under any cir-
cstances, the curing of the olive is so slow that it cannot be carried out as rapidly as the fruit arrives at the factory so that some storage is necessary but it is doubtful whether it is desirable to hold fruit any longer than is necessary. Less deterioration will take place in a can than in the open and the hazards are very greatly reduced.

In case the fruit is cured directly from the tree, the olives are carried from the grader to the tanks to hold the respective sizes. The tanks are labeled with the proper data respecting the size, weight, and other information of use to the superintendent. A lye solution, sodium hydroxide, made to a strength of from 1 to 1.5 per cent is turned upon the olives. The strength of this solution is determined by the condition of the olives and the temperature. The solution needs to be strong enough to penetrate the skin quickly and at the same time not strong enough to cause burning, that is, checking the skin or causing it to lose its luster. If the solution be too weak, it is slow in penetrating and the work is irregular. Trial lots and the experience of the processor must be depended upon to make the variations. The olives are stirred at intervals and this is done by means of compressed air carried to the bottom of the tank or it may be done with a paddle. The object is to insure that the lye attacks all parts evenly and does not leave any spots where the fruits touch each other. The time required for the lye to penetrate through the skin or to a depth of about one-sixteenth of an inch when the solution is at about 60° F., is generally between 6 and 8 hours but may be reduced to 4 to 4½ hours. The depth of the penetration is tested by cutting and noting the change in color. The effect of the first treatment in the lye is watched very closely as upon it will depend in a large measure the appearance of the finished product.

When the penetration is deemed to be sufficient, the lye is drawn off and the olives washed, then exposed to the air to oxidize and set the color. The olives are stirred at intervals of 3 to 6 hours in order to avoid any spotting where two olives press against each other. In order to do this, the olives are covered with water and the stirring done with compressed air or a paddle, then the water removed. The time given to the washing and draining is usually from 3 to 4 days. The riper the olives, the longer is the time required, and the color tends toward a brown with a slight tinge of gold in it. The greener the olive, the darker will be the color after the treatment.

The olives are now ready for the second lye treatment which is conducted in the same manner as the first, but with a one-half per cent lye solution. The treatment is continued until the lye penetrates to one-half the depth to the pit and is usually from 3 to 5 hours. It is then washed out and the olives exposed to the air and manipulated as before but the time is reduced to from 24 to 36 hours. If the first lye solution was above 1.2 per cent to 1.5 per cent, then the second may be made 0.75 per cent instead of 0.5 per cent.

The third treatment with lye is with a 0.5 per cent solution, and is allowed to penetrate to the pit, then washed out during a period of 24 hours, as in the previous cases. A fourth application of lye may be made and is preferred by a number of packers, especially when the work is not pressing. In the early history of the industry, one application of lye, or at the outside two, were considered sufficient, but there is uniform agreement now that either three or four applications produce a better appearance than two and
the danger of burning and softening is lessened. A further advantage is that the first application does not have to be so strong. It has been found, too, that the use of salt in the water used in washing between the applications of the lye hastens the action of the lye and at the same time checks the growth of many organisms. The addition of salt to the lye solution has been tried but abandoned. Many of the packers prefer to place the olives in a weak brine, 2.5 per cent, for a few days before starting the lye treatment. It has a slight hardening effect upon the tissues which is beneficial.

It must be apparent from the foregoing that the treatment of the olive to free it from its bitterness and to effect an artificial coloring requires considerable time and labor and that preparation of the fruit upon an extensive scale involves a large outlay of capital for tanks and storage rooms. It also subjects a delicate product to prolonged exposure under conditions which are certain to be attended with more or less loss. Attempts have been made to shorten the time necessary for the treatment and also to lessen the labor. These are reflected in four patents, from which certain parts are quoted to indicate the means employed or proposed. An earlier patent applies to the removal of the bitter principle.

**Hann Patent**

The first patent granted in this country for a method of removing the bitter flavor of the olive was issued to Rosa Dean Hann, Orland, California, and is No. 1,182,270, May 9, 1916:

Hitherto the bitter flavor which makes the fresh ripe olive absolutely inedible has been removed either by a slow treatment with water and common salt (sodium chlorid) or by a more rapid treatment with a solution containing the carbonate of an alkaline element (e.g., potassium, sodium, etc.) and also, either simultaneously or later, a solution of common salt (sodium chlorid). In both cases the use of sodium chlorid has been regarded as necessary in order to prevent the softening of the flesh of the olive and to enable it to withstand the necessary handling without falling to pieces before its bitterness shall have disappeared sufficiently to render it fit for drying as a food.

My improvement is rendered practicable by heating to a temperature of about 175 degrees F., the first solution in which the fresh ripe olives are placed, whether the same be a water or an alkaline solution, and by leaving the olives in this previously heated solution until it has cooled, or (if it be a water treatment only) not more than 12 hours. Such heating serves to soften the waxy coating of the surface of the olive and enables all subsequent treatments to affect the inner substance of each olive more promptly, more completely and more uniformly than they would if compelled to penetrate primarily and mainly by way of the small opening at the stem end of the fruit, thus tending to prevent the fruit from breaking.

To remove the bitter flavor, I soak the olives in a solution containing 2 oz. of potassium carbonate (commercial lye) to each gallon of water for 4 hours, drain, rinse, drain again, and repeat the process until the flesh of the olive no longer appears white when cut through to the pit in the center. Two or three rinsings or short soakings in clean water are necessary to remove any excess of potassium carbonate, before drying.

**Buhles Patent**

W. O. Buhles, Alameda, California, made application for a patent February 12, 1917, and was granted letters No. 1,263,487, April 30, 1918. The basis for his treatment is to wash in running water and thus carry the necessary oxygen to effect the coloring. The explanatory paragraph is as follows:

In accordance with my invention I employ a lye solution of about one-half the strength heretofore used and while this is in some ways desirable, it is in no manner
essential. After the olives have been treated with the lye bath for a considerable length of time, they are removed therefrom and submerged in water or other liquid carrying oxygen. Water contains air in solution, and this air cures and blackens the olives, and the air or oxygen content of the water is replenished so that sufficient oxygen for completing the curing process is available. The liquid also washes the lye or a portion of it from the olives. In practice, I place the olives in a tub or vat, which is then filled with liquid, so that the olives are submerged, and flow liquid, preferably water, into the vat, preferably at the bottom, and allow the excess to overflow at the top. The liquid is preferably continuously introduced so that the submerged olives are subjected to running or circulating liquid carrying oxygen, and the flow or circulation of the liquid insures the presence of oxygen in the liquid which is in contact with the olives. The olives are subjected to this treatment for such length of time as is necessary to produce the dark brown or black color, after which they are treated with the usual brine solution.

Staley Patent

H. C. Staley, Haywards, California, filed application for a patent on the same day as the foregoing, and was granted patent No. 1,265,130, May 7, 1918. Mechanical means are employed to aerate the water.

An object of the invention is to provide a process of curing olives which greatly reduces the time required for effecting the desired result.

Another object of the invention is to provide a curing process which produces an olive of improved taste and quality.

Heretofore, olives have been cured by treating them with a lye solution and then exposing the olives to the air to oxidize the lye or by exposing them to running water, the dissolved air in the water serving to oxidize the lye. Either of these processes requires several weeks exposure to air or running water to properly cure the olives and further, the air exposure often results in burned olives of poor quality. In accordance with my process, the olives after being removed from the lye bath are cured within from three to six days, depending upon the quality and condition of the olives, thereby effecting a saving of from 20 to 25 days in curing the olives, and thereby practically trebling the capacity of any given curing plant.

In accordance with my process, I subject the olives after they have been removed from the lye tank to water which is thoroughly charged and saturated with air in very fine particles, so that it has a milky appearance. This thoroughly charged, aerated water is circulated and recirculated through the tank containing the olives, so that all the olives are continuously supplied with an excess of oxygen. The highly charged water is preferably introduced into the tank at the top and is withdrawn from the bottom, is further aerated and is again forced back into the tank, thereby providing for a continuous circulation of the aerated liquid through the olives. I have tried forcing air in small jets into the bottom of the olive tank, but air so introduced breaks up into small bubbles and rises through the water, contacting with only a portion of the olives and results in poor and improper curing, but with the continuous circulation of aerated liquid as in the present process I not only produce a perfect, cured olive, but accomplish the result in much less time than has heretofore been considered necessary. The air in the charged liquid is broken up into extremely fine particles, so that the liquid has a milky appearance and the air remains in suspension in the liquid, so that olives at all parts of the tank are subjected to the air. The liquid withdrawn from the bottom of the tank carries more or less air in suspension and this amount is increased before the liquid is again forced into the tank. The water may be changed occasionally during the process to remove from the curing bath any undesirable components. After being cured, the olives are placed in the usual salt solution.

Cruess Patent

A “Process for Pickling Olives” was patented by W. V. Cruess, Berkeley, California, February 26, 1918, and is No. 1,257,584, although the application was not made until November 5, 1917, about nine months after the two previous applications. The principal difference is in the fact that the solutions or the olives are heated.
My invention relates to processes for pickling olives. Heretofore, olives have been treated in the process of pickling with one or more dilute solutions of potash or other lye, the purpose of such treatment being to destroy and facilitate the extraction of the bitter elements from the olives. After the treatment the lye and bitter elements are extracted by repeated soakings of the olives in water. The olives are then placed in one or more salt brines and finally canned. As a result of this treatment, the olives become bleached more or less, due to the application of the lye, and the bleaching operates to make the olives uneven and too light in color. To counteract this effect upon the olives by the treatment described, the olives are exposed one or more times to the air, either during or subsequent to immersion in the lye solution. Exposing the olives in this way to the action of the air tends to darken and equalize the color defects of the fruit. The bleaching of the olives is an objectionable feature of the known process for canning the fruit. Aside from this, such process possesses the following disadvantages:

1. The time consumed from the beginning of the application of the lye treatment to the olives to the completion of canning is from three to six weeks, or longer.
2. The pickling vats and other parts of the equipment of the pickling factory can be used only twice, as a general rule, in one season. This limits the capacity of the factory.
3. A great deal of hand labor is necessary in turning and stirring the olives during exposure to air to darken them. This labor is costly.
4. This stirring results in a great deal of bruising of the olives.
5. Because of the great length of time necessary by the usual method, the olives are exposed to decomposition by bacteria. A very appreciable amount of olives is lost in this way.
6. The color of olives colored by exposure to air is not uniform because the points at which the olives are in contact with each other are not exposed to the air as much as the remaining surface of the olives, and light spots result at these points of contact. The flesh of the olives colored by exposure is darkened; a very objectionable feature.
7. Small vats must be used. If large ones are employed the weight of the olives during exposure to the air will crush and bruise the olives in the bottom of the vats.
8. Some olives require an excessively long exposure to the air. This long exposure results in injury to the texture and quality of the fruit.

The object of my invention is to provide a simple process easy of application, which will obviate the disadvantages of present processes, as hereinbefore particularized. To accomplish this end, I treat the olives with one or more solutions of potash or other lye substance; this lye solution being heated before addition to the olives or during the treatment of the olives with the lye solution, or the lye solution is added as in present methods without heating.

After the lye treatment, the olives are subjected to treatment with running water or liquid which is made or allowed to flow over and between the olives, with or without aeration of the water or liquid. Or the olives are subjected to treatment with water which is not caused to circulate or flow. The water is heated before or while it flows over and between the olives. Aeration of the water or liquid during the treatment is not an essential part of the process and is not necessary to its successful application.

The novel feature of my process is the heating of the water and other liquids used in the pickling process or the heating of the olives themselves. Circulation of the water or other liquid used in treating the olives may be accomplished by drawing the liquid from the bottom of the pickling tank or container and pumping it back over and between olives; or water from a tank or reservoir or other source of supply may be allowed to run over and between the olives and out of a vat to a sewer or allowed to escape in any other way, being used for the olive treating only once. It may also be allowed to flow from the pickling vats into a sump or receiver of any convenient kind and then be pumped to a tank or reservoir elevated above the pickling tanks or vats. It may then be allowed to flow by gravity back through the pickling tanks or vats.

The water or the liquid may be heated in the supply tank or reservoir from which it flows to the pickling vats or tanks, or it may be heated in the pipes used to deliver the liquid to the pickling tanks or vats; or it may be passed through and heated in any suitable form of heating apparatus placed between the supply tank or reservoir and the pickling tanks or vats; or the water or other liquid may be heated in the pickling vats or tanks themselves.
The circulation or flowing of the water, or other liquid over and between the olives may be omitted. The water or other liquid may be simply allowed to stand without circulation or flowing on the olives in the pickling vats or tanks. It is kept heated in the vats or tanks or is heated before being added to the pickling vats or tanks. The water or other liquid may be changed often to facilitate removal of the lye from the olives and darkening of the color.

My process may be applied in the method of pickling olives where they are exposed to the air to darken them. In this case, the lye, the water, and brine are heated or only one or two of these liquids may be heated as desired.

The advantages obtained in practicing my process may be briefly summarized as follows:

1. It avoids exposure of the olives to the air to darken them.
2. It decreases the amount of labor necessary in handling the fruit.
3. It diminishes the length of time necessary for curing or pickling the olives. Where heated flowing water is used as described in my process for pickling olives after the lye treatment, it is possible to complete the pickling operation in three to six days as compared with three to six weeks.
4. The output of the factory can, therefore, be greatly increased because the pickling vats can be used several times during the season.
5. The color of the olives cured or pickled by my process is uniform and localized near the surface.
6. There is no danger of loss of olives by bacterial decomposition, because the time necessary for my process is so short that this decomposition cannot take place.
7. It enables large pickling vats to be used in the pickling or curing of olives.
8. It results in olives of uniformly good quality and color, and eliminates to a very large degree the element of chance now so prominent in present methods of pickling olives.

Wolff Patent

A further modification of this step in the preparation of olives is covered by patent No. 1,393,873, October 18, 1921, issued to H. N. Wolff, Oroville, California. The following is quoted:

According to my process, the olives are first graded for size and unit lots of them are charged into containers comprising perforated baskets. The baskets are then sunk in a vat containing a lye solution of suitable strength, preferably 2 per cent, and allowed to remain a given time, preferably about three hours. Treating with this solution is largely for the purpose of cutting the outer skin of the olive for the coloring effects. During this period, the lye solution is in circulation through the vat and over steam coils which maintain the solution at a given temperature, preferably about 70 degrees F. The solution passes through the perforated walls of the basket and flows about the olives therein which are moved about occasionally to permit an even action of the solution, by an air stirrer of known form, inserted into the vat.

After exposure to this solution for the requisite time, the baskets are removed and sunk in a vat containing water which is also kept circulating and at a constant temperature of preferably about 60 degrees F. The olives are stirred sufficiently to insure a thorough washing, and the baskets are then lifted out and immersed in a vat containing a relatively weak solution of lye, preferably 1 per cent, and at a temperature of about 70 degrees F., and allowed to remain in this solution with occasional stirring until the bitter elements have been entirely removed by the neutralization of the acid in the olive. Ordinarily this will require about five hours. After treatment of the olives in the second lye solution, the baskets are lifted out and immersed in a second water bath and allowed to remain there until the olives are freed from all the caustic, which will require twenty-four hours or more according to the texture of the olives being treated.

After emerging from the wash water, the olives are put into brine storage tanks until packed.

The strength of the lye solution may be kept at the requisite point, tests by titration being made as desired. Fresh water may be added to the washing vats as required. There is, therefore, the highest economy in water and solution.

It will be noted from the above: First, that the fluids through which the olives have passed are kept circulating through the respective vats and are maintained at substantially constant temperatures. Second, that a given lot of olives is handled as a unit
through the lye and washing fluids being transferred in its container or basket out of one and into another, as its own requirements dictate. Third, that a large number of such unit lots, limited only by the size of the vats, may be in course of treatment at one time, each unit entirely independent of any other unit, and a continuous succession of units being kept moving through the vats in which the same liquid is used over and over again.

**Holding the Olives in Storage**

Instead of placing the fruit directly into the lye when it is brought to the factory from the orchard, the alternative is to put it into a brine holding-solution, and the majority of packers prefer to do so even for a few days as a preparatory step to lyeing. The plant cells are killed and the osmotic processes are made more uniform. Probably 80 per cent of all the olives are placed in a salt solution as a matter of convenience or necessity in order that the factory may work on a constant and definite schedule. None of the factories can handle the olives as they arrive at the peak of the picking, and irregularities in ripening due to weather makes the picking fluctuate through wider limits than can be met by the ordinary supply of factory labor. Holding solutions not only take up these irregularities but prolong the period into the winter when the labor costs are less than in the fall.

It may be explained that when ripe olives are placed in brine, the operation is now designated as curing, whereas when green olives are placed in brine it is now called pickling; also that the one who directs the work with ripe olives is called a processor, and with green olives a pickler.

When the olives are placed in brine, the initial solution is usually 2.5 per cent in order that there be no shriveling or shrinking, and the strength is increased about one per cent each day until it reaches 10 per cent. If the weather be warm, above 70 degrees, the initial solution may be 5 per cent, and the building up process may be a little more rapid the first two or three days, while if the temperature be cool, the whole process may be somewhat retarded. A solution of less than 5 per cent of salt retards bacterial action, above that and less than 10 per cent inhibits growth of a great many organisms but permits a good growth of the lactic acid producing forms. All forms are arrested when the strength reaches 12 per cent. If the water supply be cold and the olives are to be held only from 30 to 45 days, then it is customary to keep the brine below 7.5 per cent as a higher percentage tends to cause shrinkage and hardening of the tissue so that it does not return to the normal in washing out the salt and lyeing. The olive has a rather resistant skin and a firm tissue so that neither high percentages of salt in the initial stage nor heavy reinforcements can be made at one time without doing injury, in which respect it differs from the cucumber. If the holding is to be continued for several weeks, then the brine needs to be increased to between 10 and 12 per cent at a pretty rapid rate to avoid any change except that of the lactic acid fermentation and, as a protection to the brine against outside contamination, it may be covered with a layer of refined mineral oil. This prevents the growth of organisms which require oxygen and utilize the lactic acid in the brine solution.

In increasing the salt in a brine, it is better to use a saturated salt solution rather than the crystals. The latter sink to the bottom, dissolve slowly, and make a stronger brine at that point than above. Experience has also shown that hard water is better in this case than soft, which is the reverse of that for most fruits and vegetables.
One of the troubles arising in the holding solution is the spotting of the olives. These occur as darkened circular areas with a lighter colored ring around the edge. They may be as small as a pinhead or become a quarter of an inch or more in diameter. Someone called these fish-eyes and unfortunately the appellation holds. The cause has been found to be bacterial, the form being one of the colon aerogenes group. It is water borne and also probably carried by other means. A practical preventive remedy has not been worked out, though experiments indicate that a means will be found.

Olives which have been given a brine treatment are soaked in water and changes made every twenty-four hours or oftener to remove the salt. It is not necessary to remove the last traces as a very small quantity seems to favor the action of the lye. The lyeing is conducted the same as for fresh fruit.

After the lye has been washed out, the olives are in a very unstable condition and liable to be attacked by any organisms which may gain access to them. Spoilage progresses rapidly, particularly when the weather is warm. To guard against such loss it is recommended that the olives be pasteurized at 175° F. for 30 minutes, a somewhat higher temperature than most products require. The work should be so planned that no delay in canning will occur when the fruit is ready.

Testing for Lye

The elimination of the last traces of lye is one of the most important steps in the preparation of the olive for canning. If any lye remains, it has the same effect when processing as does alkali upon vegetables, to cause softening and change of color. The change of color from black to a bleached effect bordering upon brown is more pronounced in tin than in glass containers. A test for the elimination of lye is by the sense of taste, but that introduces a personal factor and is not sufficiently delicate. A test on expressed juice or on the cut surface of the fruit, using phenolphthalein as an indicator, has been tried but not found wholly satisfactory. Prof. Cruess has worked out a colorimetric test based upon the hydrogen ion concentration which is more reliable. The tests are made as follows: "The juice is squeezed from a handful of olives, Brom-thymol-blue or phenol red indicator is added, and the color matched as closely as possible with those of the Clark Hydrogen Ion Color Chart."

Final Grading

During both the lye and salt treatments the olive undergoes some change. The lye neutralizes the natural acidity of the fruit or that acquired by lactic acid fermentation if held in a salt solution as a preliminary step. It also combines with some of the fruit constituents, as the bitter principle, and to a slight extent saponifies fat and these are washed out in getting rid of the lye. The salt acts by osmosis in entering the fruit, and to effect this interchange some moisture is drawn out. If the salt solution be too strong, shriveling results, which can be corrected only partially in the subsequent operations. It is for this reason that salt solutions should be built up so as to permit the tissues to adapt themselves to the changes without showing
ill effects. The change in weight effected by these agents is slight. The change in volume is more apparent and is due in part to slight softening so that the fruit settles more closely together. The change in weight is ordinarily less than 2 per cent, while in volume it may be between 5 and 10 per cent.

The olives when ready for packing are a totally different product from their European ancestor. No after fermentation is permitted, or at least not intentionally, after the lyeing. If the olive be fermented in the holding solution before the application of lye, then the acidity is neutralized by the alkali so that the product is devoid of the flavor which has been associated with olives as long as they have been eaten. Whether the new product is better or not is a matter of personal taste. But with this change has been brought about some difficulties in preservation.

The olives are regraded for size on the machine and given a final inspection for color and to eliminate any soft or unsuitable material.

Filling

The cans or jars are hand filled and the olives covered with a 2.5 to 3 per cent brine, or it may be less if salt be used in the water when leaching the lye. The cans are heated in the exhaust box until the liquid reaches 160° F., or more, before sealing.
Cooking

The cooking is regulated by the California State Board of Health, and at present the prescribed treatment is that the olives be treated in the retort at 240° F. for 60 minutes or 250° F. for 50 minutes. They are then cooled at once. It is also required that the pack be so code-marked that any package may be identified as to the factory, date of packing, and retort batch. The packer usually adds marks to indicate the variety and size. No other fruit is subjected to such rigid requirements.

Heat penetration in the olive takes place more slowly than is generally recognized. Experiments were made in which a hole was drilled into the center of the pit and thermometers with specially small bulbs inserted to get the temperature. The stem was guarded from conducting the heat by surrounding it with rings of olive. It required on an average 14.5 minutes for the temperature to rise from room temperature to 200° F. inside Jumbo olives when they were transferred directly from the room into boiling water. It required 29 minutes to reach the same temperature when the olive was placed in water at room temperature and heat applied to the jar so as to bring the temperature to boiling as quickly as possible. The latter
corresponds more nearly to the conditions in canning such as were formerly used with the open vat. The temperature inside the olive could not be brought above 209° within a reasonable time. When one considers that prior to 1918, practically all the cooking was done at boiling and oftentimes in a period as short as 35 to 40 minutes there is little wonder that trouble developed.

The California regulations have been extended to include other olive preparations as minced ripe olives: Pitted olives No. 2 and No. 2½ cans, 240° for 80 minutes; olives stuffed with pimientos, almonds, or anchovies in glass, 250°, 50 minutes; minced olives, 4 oz., 250°, 60 minutes; No. 2½ can, 120 minutes, and No. 10 can, 240 minutes, and in addition the initial temperature must be 180°.

In experiments reported, it is claimed that neither 240° nor 250° of heat sensibly alter the flavor of the olive, which is contrary to what happens with most fruits and which is questionable in this case.

Plain tin, enameled, and re-enamed cans have been used. Olives bleach and become grayish brown in plain tin, and the amount of discoloration increases with time. The color is well retained in enameled and re-enamed cans, particularly the latter, but these are not wholly free from a foreign flavor. By adjusting the alkalinity or acidity within the range previously indicated, the change in color can be materially lessened. Color and flavor are both conserved in glass.

The olive packers began the packing of olives in extra tall or cylinder cans in order to have something which would be distinctive and identify their product on the grocers' shelves. This type of can is more costly than the regular and also inherently weaker, hence the trend in packing is toward the regular No. 1, No. 2, No. 2½, and No. 10. There is also a return being made to glass jars.

**Label Weights**

- 8Z Short, 4½ ozs.; 8Z Tall, 4½ ozs.; No. 1 Tall, 9 ozs.; Pint, 9 ozs.; Quart, 1 lb. 2 ozs.; No. 2½, 1 lb. 2 ozs.; No. 10, 4 lbs. 2 ozs.; Full Gallon, 5 lbs. (Declare as "Drained Weight.")

**H. P. and J. Burt Patents**

Two process patents upon the packing of olives have been issued to H. P. and G. Burt, Palermo, California. The first is No. 1,208,909, December 19, 1916, and the second, No. 1,238,708, August 28, 1917. The following is from the earlier one:

This invention relates to methods of preparing and packing ripe olives, for preservation, and sale.

In carrying out the invention, we pickle the olives in the usual manner; that is to say, the use of solutions of caustic soda (lye) and salt, which extracts the bitterness and flavors the olives. The olives are then sterilized by the use of a sterilizing liquid, by steam or otherwise.

When the liquid sterilizer is used, we drain off the liquid, or otherwise remove it and then seal the fruit in a partial vacuum in suitable containers. The containers may be of any suitable material, as glass or metal.

When the liquid is removed from the olives, either before or after sterilization, a reaction takes place, due to the exposure of the fruit to the air, which reaction is preserved or continued when the fruit is sealed in vacuo. By this reaction the quality and appearance of the fruit is greatly improved, the dark color of the fruit is intensified and better preserved, there is no liquid in the container to take up coloring matter from the olives and other desiderata are secured.
Having thus described our invention, and an embodiment of it in the full, clear and exact terms required by law, and knowing that it comprises novel, useful, and valuable improvements in the art to which it pertains, we here state that we do not wish to be limited to the precise terms and steps and arrangement of the several parts, as herein set forth, as the same may be variously modified without departing from the spirit of the invention.

The second patent varies from the former in that the olive may be sealed in containers in vacuo and then sterilized.

Other Preparations

Olives which are too small or misshapen to be used in the regular pack are sometimes used for other purposes besides oil extraction in which size and appearance are not factors. The flesh is grated from the pits and is seasoned and thus furnishes a mixture for relishes and sandwich filling, or the flesh is mixed with pickled cucumbers, capers, pimiento, tomato, etc., in various combinations for the same purposes or to flavor sauces. The appetizing ways in which olives may be used alone or in combination, and the attractive dishes which can be prepared from them are endless. This is not an innovation as may be learned from Cato's recipe for Epityrum (119) in which no favorites are played among the olives nor condiments: "Select some white, black, and variegated olives and stone them. Mix and cut them up. Add a dressing of oil, vinegar, coriander, cumin, fennel, rue, and mint. Mix well in an earthenware dish, and serve with oil."

Pickled Green Olives

The packing of pickled green olives is gradually being developed according to the methods generally followed in the Mediterranean region and also with certain modifications being developed locally.

By-products

Olives not used for canning or pickling green are converted into oil. This requires a special equipment and a technology of its own. Two grades of oil are made, the best for the table and for pharmaceutical uses, and the second for soaps, lubricants, and other industrial purposes. The residue from the presses is dried and makes an excellent stock food.


In the opinion of the department packages of olives in brine should be marked with the statement of the net weight of the olives exclusive of the brine. This should be stated in terms of the largest unit contained in the packages.


In the opinion of the bureau the ruling published in Service and Regulatory Announcements, August, 1914 (S. R. A., Chem. 8), letter No. 77, with reference to olives in brine, is applicable also to the method of declaring the quantity of contents on the labels of olives in cans.


The bureau has received numerous complaints that certain olive packers were packing immature, unripe olives under a labeling which would indicate the product was a mature, ripe olive, and that these packers so manipulated these immature olives during the process of packing as to give them the characteristic appearance of a ripe olive when packed. Such immature olives, mislabeled as ripe olives, would be regarded as in violation of the Federal Food and Drugs Act if brought under the jurisdiction of the act. An extensive investigation of the changes that occur in the composition of
olives during ripening has been made. The results obtained indicate that the index of maturity for olives is the oil content of the flesh.

As a tentative standard of maturity for Mission olives and other common varieties except Manzanillo, Ascolano, and Sevillano, an oil content of 17 per cent in the flesh is regarded as a minimum. The Manzanillo olive should contain a minimum of 15 per cent of oil in the flesh to be regarded as ripe or mature. Olives containing less than the percentages of oil in the flesh specified above would not be regarded as ripe or mature, and when brought within the jurisdiction of the Food and Drugs Act would be regarded as in violation thereof, if labeled as ripe. For the large-fruited varieties, such as Ascolano and Sevillano, no standard of maturity is proposed, since these varieties are, of necessity, gathered when immature. Such olives cannot properly be designated or labeled as ripe.

These minima for the oil content of ripe olives are to be regarded as tentative. The bureau will welcome such suggestions and representations in regard to them as the trade may desire to make. Should it be determined at a later date that the minima above given should be changed in any way, due notice will be issued by means of a service and regulatory announcement.

ORANGES

Citrus

The canning of oranges is an important industry in Spain though until lately little attention has been given to the product in other places. The orange most used in Spain is the Seville, a sour type put up as stock for marmalade. It is largely exported to England and Scotland and other points in Europe, but only small shipments have been received here. The foreign demand is for a tart marmalade so that by combining Seville pulp with the sweet orange a more acceptable product is obtained. The use of canned Seville stock enables the manufacturer to take advantage of the low cost of the sweet oranges when they are plentiful. The Spanish also can sweet oranges for table use.

The method of preparation of the pulp is as follows: The oranges are first thoroughly washed in warm water, using stiff brushes if necessary to remove the dirt from the surface. They are next cut in halves on the transverse axis. The pulp is scooped out with a special blunt spoon and the seeds separated at the same time. The pulp is put in a kettle and boiled slowly for half an hour after which it is worked through a coarse pulper or screen. The skins are run through a sheer which cuts them into thin long shreds, the thinner the better, and sufficient water added to keep the shreds separate. They are kettle cooked by themselves from 45 minutes to one hour and are then mixed with the pulp, filled into the cans while hot, sealed, and given an additional cook at boiling for 15 minutes. In order not to have too much peel, some of the packers cut each end of the orange off to the thickness of the rind. No. 10 and larger cans are used.

The marmalade manufacturer combines the Seville pulp with the fresh sweet orange in such proportions as to produce the desired flavor. It does not permit as transparent a product as when all fresh material is used but that is secondary in importance to flavor.

Sweet Oranges

The Spanish select a rather loose, thin skinned variety of orange somewhat similar to our Satsuma. The peel is removed by hand and the seg-
ments broken apart with as little rupture as possible. The segments are placed in the cans and covered with a sirup of approximately 30 degrees. The cans are given a long low exhaust, about 20 minutes or more at 175° F., followed by a cook for from 25 to 30 minutes at 185° to 190° F. The work is done at the lowest possible temperature at which they will keep in order to conserve the flavor. The cans used correspond to our No. 1, No. 2, and No. 2 flat.

Japanese Orange Packing

The Japanese have been packing Mandarin oranges for about ten years and are making headway in finding an outside market for their product. The Mandarin orange is a decidedly hardy type similar to the Tangerine and Satsuma known in this country. It is of medium size, distinguished by having loose connective tissue beneath the skin and between the segments, thus permitting easy removal of the skin and separation of the segments. The flesh is decidedly high colored and well flavored. The chief production is on the west side of the island in the Osaka district.

The fruit is taken when well ripened, graded for size, and held in boxes or crates in storage from five to fifteen days depending upon the condition. The effect of the storage is to make the separation of the peel easier and to induce in the segments a better condition for handling. It is said that this also lessens the tendency for the product to develop the terpene flavor after packing.

The peel is slit, but not cut through, with the point of a knife, dividing it into about four sections. This is for the purpose of assisting in tearing it off evenly over the entire surface. If the fruit be directly from the tree or the skin be adherent from immaturity or uneven ripening, they are dropped into hot water (185° F.) for about half a minute. This has a softening effect similar to that obtained with grapefruit, thus facilitating the removal of the rind. The peeled fruit is placed in a single layer on trays and exposed to the air for an hour to get a moderate drying. In some places the trays are slipped into a dryer using a current of air to not only get uniformity in the drying but also to hasten the action.

The fruit is then segmented, each segment being covered with its own membrane to which are attached ragged bits of loose fiber. The segments are dropped into pans of cold water and held for peeling.

The peeling of the segments is the next step and done by means of the lye bath. The apparatus is of very simple construction, consisting of a long narrow tank with an open conveyor, and a closed heating element. The lye solution is made very weak, about four-tenths of one per cent, and heated to a temperature of about 200° F. or slightly less. The segments are placed in small wire or perforated baskets that are carried through the bath in one-half minute and then directly through a tank of cool water. The water is circulated rapidly so as to turn the segments gently and to carry off any shreds of the cauterized fiber. The fruit is next turned into enamel pans and kept covered with water. These pans are also small, holding only 2 to 4 quarts, thus avoiding any pressure which would tend to break or flatten the pieces. The segments are sorted for size and trimmed if it be necessary.

The filling of the cans is done in a unique manner, different from any-
thing in this country. The cans are filled with water and then the fruit added, after which they are inverted and drained. This is followed by adding a saturated sirup or by dry sugar. The segments fit so closely that little sirup can be used, and as it combines with the juice, appears low in the cut-out. The heavy sirup has an advantage in giving firmer texture to the segments and in preserving their form. Plain cans are used, chiefly in two sizes corresponding to our 8-ounce milk can and the No. 1 Tall.

The Japanese prefer mechanical vacuumizing and sealing of the cans to exhausting in the steam box. The claim for the former is the retention of esters which are dissipated with heat, a better flavor and texture. If the exhaust box be used the time is given as about 5 minutes, enough to raise the temperature to about 140° F. Sterilization is easy, the time in the bath is from 10 to 12 minutes for the 8-ounce can and from 15 to 16 minutes for the No. 1 can, followed by immediate cooling.

Domestic Canning

Little orange canning has been done in this country due to the fact that in following the usual canning methods deterioration occurs in the flavor and appearance within a few months. Extensive research has been made by both the citrus industry and individuals to produce a satisfactory stable product, resulting in progress but not in attaining complete success. Three conditions must be met: to avoid introducing any part of the skin, to limit exposure to the atmosphere to the briefest possible time, and to sterilize at a low temperature, not above 185° and preferably at about 165° F. The reasons are obvious as the use of any part of the skin introduces terpenes which impart an objectionable flavor, exposure to the air starts an oxidation process, and a high temperature changes the delicate aroma and flavor which is distinctive of the fresh fruit. The successful packing of orange juice is bringing the packing of the fruit one step nearer solution.

The Valencia orange gives a distinctly better product than the Navel variety but neither compare favorably with the Satsuma, but not enough of the latter is available to figure in a commercial pack at present.

Orange Juice

The canning of orange juice received a strong impetus when it was learned that the fruit is particularly rich in vitamin C, which is essential to growth and protects health to a marked degree. Beginning about 1930, large sums were expended upon various methods of preservation as pasteurizing, canning, holding in cold storage, and quick freezing, and large scale experiments were made in distribution in connection with dairy delivery, through grocery stores, and soft drink parlors to test public interest but the methods were not entirely satisfactory and progress was slow. In 1934, renewed energy was put into canning experiments to produce a product which would make an outlet for the ever-increasing orange crop. The results were far more favorable, and in the season of 1935-36 the total pack reached nearly 2,000,000 cases.

The procedure may be summarized as follows: Fully ripened Valencia fruit, which, owing to size, shape, color, or skin blemishes, or other fault, renders it unsuitable for standard packing, are used. Fruit, as windfalls, frosted or otherwise damaged as to affect quality or flavor are unsuitable.
The fruit is held in storage for a few days, washed to free it from dirt, cut in halves on the transverse axis, the pulp removed by means of a power burr, the juice filtered to remove seeds and any coarse particles of fiber, the filtering being done in a chamber into which steam is directed to keep the atmosphere saturated, the juice passed through a flash heater or heated by a coil until it reaches 160° F., filled into cans and given a final cook at 180° F. for 20 minutes for No. 2 cans and smaller sizes.

The cutting of the orange and placing the halves on the burr are hand operations as no machine has been developed which will do the work equally well. Attempts have been made to cut the skin off the ends, to squeeze out the juice, to peel the fruit and crush it in a screw press, but fully mechanized methods incorporate too much peel so that while satisfactory for serving fresh juice they are not equally well adapted for the canned product.

Special equipment has been designed for the washing, conveying of the oranges, tables with burring machines, juice collecting systems, filters, etc., using stainless steel on all parts coming in contact with cut fruit or juice.

Special enamel cans are used for canning oranges and orange juice; also glass containers.

**Label Weights**

(Fluid measure) 8Z Short, 7 ozs.; 8Z Tall, 7½ ozs.; Picnic—No. 1 East, 9½ ozs.; No. 300, 13½ ozs.; No. 1 Tall, 15 ozs.; No. 303, 15 ozs.; No. 2, 1 pt. 2 ozs.; No. 2½, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; No. 10, 3 qts.

**Composition**

The composition of the orange as given in Circular No. 50, Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>28</td>
</tr>
<tr>
<td>Water</td>
<td>87.2</td>
</tr>
<tr>
<td>Protein</td>
<td>.9</td>
</tr>
<tr>
<td>Fat</td>
<td>.2</td>
</tr>
<tr>
<td>Ash</td>
<td>.47</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>11.2</td>
</tr>
<tr>
<td>Fiber</td>
<td>.6</td>
</tr>
<tr>
<td>Sugars</td>
<td>8.65</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>.78</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>50.2</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>230.</td>
</tr>
</tbody>
</table>

**F. I. D. 182**

Orange (common, sweet, or round) is the sound mature fruit of *Citrus sinensis* Osbeck. The juice of the mature fruit contains not less than eight (8) parts of soluble solids to each part of acid calculated as citric acid without water of crystallization.
After examining all available evidence, Alphonse De Candolle came to the conclusion that the home of the peach was in China, not Persia, as generally believed. The peach has been known to the Chinese as long as they have had records, certainly for centuries before any mention of it occurs in any western Asiatic countries. It apparently came westward from Persia which doubtless accounts for assuming that it was native to that country, but as those people had contact with the Chinese, it is reasonable to suppose that it was obtained from that source. The fact that no term occurs in the antecedents of our language which refers to the peach is taken as proof that it was not known to the people of the time as no fruit of such merit escaped attention. It is first mentioned by Theophrastus (322 B.C.) which is believed to indicate that it was brought to the Mediterranean region as a spoil by Alexander the Great in his conquests.

The peach was distributed rather slowly over Europe, first in the south and then extended northward where in turn other strains were also being introduced by the hordes of Tartars in their migration from Asia over a northern route. The peach did not prove as readily adaptable to the varying climatic and other conditions as some of the other fruits and, furthermore, it flowered so early that the crop was frequently cut short by freezing so that it did not become an outstanding useful fruit though it was appreciated for its fine qualities. Many varieties were developed by horticulturists but in none is there any marked deviation from the original or wild type.

The peach was introduced into this country in Florida and along the Gulf Coast by the earliest Spanish settlers and later by immigrants farther north. The varieties brought to the South were not especially good though probably the best then suited to that climate. The conditions for growth proved much more favorable in the north and the tree thrived better than in Europe. This condition prevailed until the end of the last century when the tree was attacked by a disease which decimated the orchards. It is widely grown in a small way in home gardens but commercially only in certain sections as in the Southeast with Georgia as a center, in New York, Michigan, and California. The last leads in production for canning and drying, supplying more than ninety per cent of the whole. It may also be added that the peach leads all other fruits in canning though the pineapple is rapidly approaching it and may gain the leadership.

**Horticultural Characters**

The peach tree is of moderate size, usually under 18 feet in height, not very robust, with a loose head; bark rather light colored; leaves long and narrow; flowers in clumps set close to the small branches, generally of a pinkish color; fruit large, from 1 1/4 to 3 inches in diameter, generally globular, drupaceous with a wrinkled pit covered with a thick pulp and downy skin. The fruits are divided into two classes, freestone and clingstone, depending upon the freedom or adherence of the pulp to the pit. The color of either or both the flesh and skin may vary between the light
almost white, through deep cream, light and deep yellow, pink, and red. The color most sought is a medium yellow.

The tree is only moderately hardy, being winter killed in severe weather, and the bloom injured by light frost; it is subject to both insect and fungous attack. The liberal use of fungicides and insecticides has greatly increased its longevity and productiveness. The tree is not long lived, or rather, it is not profitably productive over a long period. In the West the orchards are generally replaced within sixteen years.

The peach is closely related to the almond which has almost no pulp over the pit and also to the nectarine which differs from it mainly in having a smooth skin.

There are many varieties of both freestone and clingstone peaches, the freestone being preferred for the fresh market and the clingstone for canning. The ease of freeing the fruit from the pit is an advantage in one case and the improved appearance of the pit cup due to mechanical removal for canning in the other. The generally firmer flesh associated with the clingstone is also an advantage in canning. Some varieties have a richer and more decided flavor when fresh than after heating, while the reverse is the case for other varieties. This is so generally true that it is futile to use the surplus of fruit intended for the fresh market for canning purposes, especially if a first grade product be the objective. The two lines are so distinct that it is necessary to select the varieties accordingly. The Crawford has been considered the best canning peach in the East while in the West the Lovell and Late Crawford are given preference for freestones, the former ripening in August and the latter in September. The Tuscan Cling, Hauss Cling, Orange Cling, and Phillips Cling are equally prominent in the clingstone class. The first begins ripening in July and the others follow in succession into September. One requirement in a good canning peach is that the pit be relatively small and the flesh thick. A peach with a large pit and thin flesh produces halves that flatten after cooking so that they are less attractive than the opposite type even though the flavor be equally good or better. Freestone peaches are at a disadvantage in that the pits are generally larger than in the clingstone, the cup not so clean cut, often a jelly-like layer forms after lye peeling, and furthermore, they are prone to have a reddish color or streaks radiating from the center. This reddish color is rather an asset with fresh fruit but not so with canned. A further disadvantage is the tendency to have split pits with the attendant discoloration and often infection with organisms resistant to the regular sterilizing operations.

Extent of the Canning Industry

The growth of the peach canning industry is best shown by the statistics and while the figures are too large to be readily comprehended, they at least are comparative. The figures are for California only, but since the rest of the country packs only about a quarter of a million cases annually, these give a very nearly true basis for comparison.

The peach pack represents practically two-thirds of the pack of all fruits in the state and leads all others for the entire country. The volume exported is also an indication of the high regard with which it is held abroad as well as at home.
Field Production

The growing, picking, and handling of the crop has been developed for the canner. Varieties that give the best results are planted and selected with reference to securing fruit continuously over a long season to avoid a peak at any one time and to better distribute the labor. The pruning, thinning, and irrigation are carried out with reference to producing size, evenness of coloring, and texture of the fruit.

The harvesting is done near the end of the hard ripe stage but before softening since it is to be prepared at once and must not reach the point where it yields in the hand or breaks down in cooking. Varieties which mature at the same time are kept separate and worked through the factory in different lots in order to obtain uniformity in the finished product.

The fruit is hand picked to avoid any bruising and is filled directly from the bucket or bag into the lug boxes. Since only fruit in prime condition can be handled to the best advantage, it follows that the picking should be distributed over at least four periods. To strip the trees in too few operations results in taking some fruit when too far advanced and other fruit still hard, thus increasing the percentage which must go into lower grades. The green fruit is not as objectionable as with the apricot, nevertheless, it is deficient in the rich flavor of maturity and retains some of the astringency of immaturity. The lug box holds about 50 pounds and affords better protection in the handling in the orchard, on the truck or car, and in the factory than any other style of container. It is needless to add that the maximum of protection is obtained only when delivery to the factory is made promptly.

Fresh Fruit Contract

The contract for California peaches provides that “all fruit covered by this contract shall be of good color, shape, quality, and in good condition for canning, at the state of maturity Buyer may require, free from doubles, worms, scab, frost rings, hail or rain damage, red streaks in flesh, windfalls, visible split pits, parasites, fungi, bruises, spray residue, gum or other imperfections.”

“No. 1 Peaches shall be 2½ inches or more in diameter. No. 2 Peaches shall be not less than 2½ inches in diameter.”

Owing to the exactions which sometimes appear onerous to the grower and the irregularities of the crop, which permit the canner to depress the price one season to twenty dollars per ton and the next, with the aid of
nature, allows the grower to exact seventy dollars per ton, the canners are assuming a larger part in the growing.

Canning

The canning of peaches is as old as the art itself. Appert gave the following very brief description:

"The large Mignonne and the Calande are the two kinds of peaches in which are united the best quality and aroma; in default of these two kinds, the best possible are taken for preserving by the same processes as those employed for apricots."

The earliest record of the canning of peaches on the West Coast is by Cutting and Co. in 1863.

The mechanical equipment for the several factory operations has been better developed than for most fruits and especially for quantity production. The conveyors for handling the fruit between different points, splitting and pitting device, grader, lye peeler, washer, blancher, slicer, filling tables, etc., have all been balanced. In spite of all these a large amount of hand work is required. In the largest peach cannery about 2,000 persons, of whom about 1,600 are women, are employed. At the peak of operation, 14,220 cases, 341,280 cans, or 12 carloads were packed in one day.

Splitting and Pitting

The factory operations begin with splitting and pitting the fruit which have been exclusively hand operations until within the past few years. A number of machines have been invented to do the work but only recently have they become reasonably successful.

In hand pitting the lug boxes are delivered to the tables and the work done directly from these. The peach is taken in the left hand in such position that a knife can cut the natural line of separation between the halves to the pit. A plain knife is used, and after acquiring some experience, this work is done rapidly. The split fruit is dropped into another box as it is time saving to split the entire lug before changing to the pitting. The split, but unseparated peach, is then seized with one-half in the palm of the left hand and the pitting spoon inserted to pass above the pit. If the peach be a freestone, a slight lifting movement will raise the top half; the spoon is then turned over, inserted under the pit and that part raised. The two halves are then dropped into a shallow box and the pit falls into the waste. If the peach be a clingstone, it is necessary that the pitting spoon be inserted to the full depth of the pit and moved to either side to cut the flesh free from the stone and the operation repeated on the other half. The pitting spoon is about an inch in length, five-eighths of an inch in width, slightly hollow, and with a cutting edge all around. The operation, though slow at first, with practice is done rapidly. An experienced operator will split and pit eight boxes of freestone or four boxes of clingstone peaches in an hour. Formerly the women who did this work made a partial separation for the grades, both for size and texture, but with the purchase of fruit on the basis of A and B grades, a separation for size is not so important though it is still advisable to separate the green from the soft fruit.

None of the splitting and pitting machines is wholly automatic or per-
A PEACH PITTER

All fruit is brought to the pitter and the halves removed by conveyors so that much has been gained in speed and sanitation in the factory.

A MODERN PEACH PITTING ROOM
fect though four of them have been developed so that they are in use. As usual one of these has advantages which place it in the lead.

The essential features of the apparatus are a pair of knives facing each other but spaced slightly more than the thickness of the pit. The operator places the peach stem end up with the line of cleavage against the rear knife and forces the fruit into position. The machine is tripped and the peach forced against the back splitting blade, is halted for an instant while a thin narrow curved blade passes around the pit and then the splitting is completed and the halves and pit fall apart and are carried away on a conveyor. The work is decidedly better than the average hand work and is practically six times as fast.

In nearly all the larger factories the fruit is carried from the pitting tables directly to the lye peeler, the object being to get the cut pieces through the peeler in the shortest time, as exposure of the cut surface results in darkening. The belt system affords an economical method of doing this and is much more cleanly than the box system.

**Lye Peeling**

Practically all commercially canned peaches are lye peeled at this time as it saves much labor, is accompanied by less loss, is more cleanly, and the fruit has a finer appearance than where hand work is employed. If the work be carried out in a proper manner, almost no trace of lye is left in the fruit and no neutralization of acidity takes place other than in the superficial layer of cells. The residue from the operation is washed off. The method is not a new one but an adaptation of one used in the home for more than a century previously. When first used, there were many objections raised against it but these passed as a better understanding supplanted prejudice.

As far as I have been able to learn, it was first described as a commercial operation by William Archdeacon,* which is as follows:

"To can fresh peaches by the latest scientific method.—Commercial.

"Have conveniently arranged, a farmer's 25-gallon dairy kettle. And a cooling tub, so arranged that cold water may flow in at the bottom through a pipe, and an opening 4 inches below the top, for an overflow, that the water may run out as fast as it flows in. To keep it cold, provide also, a 2- or 4-quart dipper, with a long handle, and \( \frac{1}{2} \) in. perforations in the bottom. Dissolve a can of concentrated lye in boiling water in the kettle, and keep it boiling hot. Fill the dipper \( \frac{3}{4} \) full of hard but ripe peaches; lay out the soft ones and pare them by hand. Now hold the dipper containing the peaches, immersed in the boiling lye a few minutes, until the skin is a little slippery and soft which the operator must learn more exactly by practice. When the peaches are scalded just enough, raise it out and drain a moment, then quickly immerse into the cold water, and by a shaking motion of the dipper wash out the lye, and by the rolling motion of the peaches rub off their shriveled and wrinkled skins which should leave them clean and white. Have also another tub of cold water, in which to immerse the dipper of peaches, and wash clean, then drain, and pass them to be cut in halves, lengthwise of the pits; remove the pits and put the fruit

---

*Archdeacon, William. "A book of recipes for the manufacture of pickles, preserves, jellies, syrups, sauces, ketchups, vinegars and canning all kinds of fruit, vegetables, meats, fish, etc." (Chicago, 1876.)
into cans, having in each two tablespoonsful of sugar; then fill them with boiling water and solder up tight, and process 15 or 20 minutes without venting, and cool immediately. By this method of removing the skins, about 25 per cent of labor and about the same amount in fruit will be saved. By this hot bath the pores of the fruit are opened, and the air to some extent forced out. And by the sudden immersion in a cold bath the pores are again closed, which better preserves the flavor, and the peaches. Great care, however, must be taken to keep the lye boiling hot, strong, clear and clean, renewing when necessary: and also the cold water baths must be kept clean and cold, by using ice if necessary. If these conditions are not strictly maintained the peaches may turn dark colored. But if all the work is performed with care and skill, superior goods will be produced at less cost. The early and late white Crawfords are the best variety of peaches for canning, and should be fresh picked from the trees as nearly as possible.

"(Note.—Test the first batch of fruit, to see if too much processed—it will show by the peach being too soft in the cans.)"

The process did not become generally known and it was thirty years later, when, as an adaptation of the method of removing the hull from corn in the making of hominy and in checking the skin on plums for drying in the curing of prunes, that lye peeling was applied to peaches.

The process consists in subjecting the halves of peaches to the action of a hot solution of caustic soda for a sufficient time to cauterize the surface layers of cells. In adapting the method to peeling peaches the fruit is pitted, the split peaches are simply submerged in the hot lye solution, then transferred to a tank of running water, jostled or stirred around in the water and any skins not removed in this simple manner are rubbed off by hand or the halves washed under sprays. This is followed by mechanical devices for conveying the fruit into and through the lye and subsequently through a washing device. Different types of mechanism have been used as drums with outside pockets, drums with an inside spiral, conveyors of different kinds, etc. The machines were simple, insured uniform treatment of the fruit in a definite time, but required close attention to keep the solution to constant strength and the temperature regulated. The highest development has been attained by applying the lye in the form of hot sprays. The used lye is filtered, pumped through a heater which brings the temperature to near the boiling, sprayed on the fruit with pressure and thus the maximum effect is obtained in action upon the skin without a general heating of the interior of the fruit. The effect is obtained with a lesser amount of caustic per ton of fruit, and furthermore, the strength can be adjusted more nearly in accordance with the condition of the fruit. The strength of the lye is ordinarily from 1 to 3 per cent, most often about 2.25 per cent. The lowest percentage is used when the peaches are ripe and with thin skins and the maximum when the fruit is unripe and on varieties having coarse skins. The time required for treatment varies from 18 to 25 seconds or longer if a weak or only moderately hot solution be used. The time may be shortened by passing the peaches through a hot water bath or spray, depending on the type of lye peeler. Passing cold peaches directly into a lye bath chills the solution and necessitates some increase in the time for the action to be completed. It also causes the solution to thicken and lowers its effectiveness. The three factors, strength of solution, temper-
nature, and time in the bath, can be adjusted to handle practically any fruit. The important advantages of the spray system are that it permits the handling of softer and therefore riper fruit, and better control of the solution.

The removal of the lye is of almost the same importance as its application and that is also done more efficiently and economically by sprays than by any other means. The spray method for both application and removal of the lye has been patented and the subject of much litigation.

Peaches which are well lye peeled are smooth and of a bright color. Freestone peaches are likely to have a brownish layer in the pit cup most of which is removed by the spraying but some of them may require a final touch of hand work on the table.

A patent, No. 1,717,647, June 18, 1929, is for a modification of the method to facilitate the handling of fruit which has begun to soften. The fruit is first chilled to 40° or below to render it firm. The halves are then subjected to the boiling lye for only eight to ten seconds so as to cauterize the superficial layer without giving time for the heat to penetrate or have a softening effect. The usual strength of solution, from 1 to 3 per cent caustic, is recommended and that it be washed off under sprays at about 80 pounds pressure.

The amount of lye required to peel a ton of peaches is ordinarily from 7 to 9 pounds for the draper type of scalder and may go as high as 15 pounds. From 3 to 5 pounds of lye suffices in the spray method if the temperature be maintained.

Lye peelers are made to have almost any capacity desired, the large ones being rated at from 10 to 25 tons per hour. If quality in the finished product be the prime consideration, there can be no doubt but that two smaller and more elastic units serve the purpose better than the very large ones.

The strength of the lye is maintained by frequent additions of small amounts of concentrated solution or the direct addition of the caustic. The strength is built up to the proper point at the beginning and the operator at the tank becomes familiar with the rate with which the fruit passes through and adds lye accordingly. In this he is guided by frequent tests of the peaches as they leave the peeler. The specific gravity test is of little use. A special electric device has been made to indicate the strength of the solution but has not proven advantageous. Simple acidity tests can be readily devised which will show whether a given volume, as 20 c.c., is above or below the desired strength and not require more than 15 seconds. Such simple tests are helpful to the operator.

Lye is obtained in the trade in drums as a solid, or in granular form. The latter is the more convenient. It is always better to dissolve it in a separate kettle and add it in solution. Adding it in the solid form is attended by foaming, particularly in the tank system after a considerable amount of skin has become dissolved in it.

Where hand peeling is followed, the peaches are first split and pitted, as already indicated, then the half peach peeled with a special knife having a blade curved approximately to the outline of the peach with a guard over the blade to limit the depth of the cut. Peelers become very expert in the work and prepare a surprising amount of fruit in a day though under any condition the costs are in excess of the mechanical method.

After peeling either by lye or by hand the fruit requires immediate
blanching to arrest the tendency to oxidation. With no, or insufficient, blanching, the peaches may become brownish within a quarter of an hour, whereas with good blanching they suffer little injury under one hour.

The blanch has a secondary effect of causing flexibility of the halves so that they fill into the cans more closely without either breaking across the body or fraying on the edges.

A few peaches, such as the Crawford, can be peeled by steaming if ripe. The peaches are split and pitted, then laid split side down in a single layer on frames that are covered with cheesecloth. The pieces are covered with one thickness of the same cloth. The frames are placed one above another in a closed box and steam turned in from two to three minutes, then taken out and the skin lifted off the peaches. The finished product has a fine appearance and is filled directly into the can. It is not an economical method, but is suited for special conditions.

Grading for Size

The peeled peaches are graded for size by running them over vibrating screens having holes, 64, 68, 72, and 76 thirty-seCONDS of an inch in diameter. These openings have been standard for a number of years. The graders take out the large or more desirable sizes first so that the fruit receives the least manipulation. The capacities of the machines are adapted to the peelers used.

The fruit is delivered from the graders directly to conveyors which lead
to canning tables destined for each size. The exception is the pie grade which is conveyed to the special line for handling that pack. The peaches are kept submerged in water until placed in the cans. Those who fill the cans make the final selection for quality, selecting halves which are alike in size, shape, color, and texture. Those which are green, soft, or imperfect are trimmed and used in lower grades. The different sizes naturally run a different number of pieces to the can, but a reasonable fill requires that the weight of fruit shall exceed 10.5 ounces for a No. 1; 13.5 ounces for a No. 2; 20 ounces for a No. 2½; and 68 ounces for a No. 10 can on the cut-out. The schedule for the grades and number of pieces is indicated in the standards.

The filling is all done by hand and while not requiring layering as in glass display jars, necessitates care in arranging the pieces in order to get the full weight, especially for the larger sizes. Better results are obtained when the fillers work upon one size only as they get a swing or order in arranging the pieces to obtain both uniformity in the fill and speed.

The cans are nearly always placed on trays to be carried to the siruping machine though a much better system is to use a conveyor. The tray system is not cleanly, which is the real objection to it. When conveyors are used, the chances of holding are reduced, and with it the tendency to discolor. At least all the regular grade on a table can be handled on a one line conveyor, thus leaving only a small per cent, those above or below the desired grade, to be placed in trays.

Before the cans go to the siruping machine they are run through a quick drainer to empty any water which may have been caught in the pieces at the canning table. The object is to prevent the dilution of sirup and thus get a more even cut-out. L. M. Graham of San Jose, California, pioneered this step but went further by first turning water into the can and then draining so as to give a final washing. Apparatus for this purpose is now a part of standard equipment.

A sirup is added by machine and there are several devices suitable for the purpose. The desirable features are: To fill to a certain point, to avoid crushing the top pieces of fruit, prevent slopping, be able to make a change from one degree of sirup to another without irregular mixing in some cans, and be capable of operating at reasonable speed.

The effect of an excessively heavy sirup, as 50 or 55 degrees, is to cause shrinkage and toughening of the fruit and to sweeten to such an extent that the delicate natural flavor is overpowered. It frequently gives the appearance of the can being short on fruit. The use of a 40 degree sirup results in a much better product in appearance, consistency, and flavor, and a No. 2½ can filled to within one inch of the top after draining the sirup. When 10, 20, and 30 degree sirups are used the fruit comes within 3/4 of an inch of the top, and with the 20 and 30 degree sirups the outline of the fruit is held better than when water or 10 degree syrup is used. The appearance of slack filling is partially due to the flattening effect produced in cooking and naturally is most noticeable in ripe fruit.

Sugar is necessary in the final preparation of the unsweetened fruit, except for diabetics or those upon a prescribed diet, and a lesser quantity produces the same sweetening effect when cooked during the canning than when added later, so that there is real economy in adding the sugar as well as getting its protective effect.
Exhausting

Almost every conceivable combination of time and temperature has been used in exhausting peaches. While a decidedly lighter exhaust can be used than with most other fruits, the best results are obtained from a moderately long low exhaust, 180 to 185 degrees for 10 minutes.

Cooking

The peach is easily sterilized, in fact so easily sterilized that the period for cooking must be set largely to properly prepare the fruit for use. A No. 2½ can is readily sterilized in 7 minutes in an agitating cooker yet the fruit generally needs from 16 to 20 minutes and frequently longer to be well cooked.

Sliced Peaches

The packing of sliced peaches has increased rapidly within the period of the arrival of the cafeteria and the kitchenette. Slicing was first resorted to in working up pie stock so as to make it somewhat more attractive, then as a means to utilize halves that were so large as to be unsuitable for the regular trade. The advent of the cafeteria brought a demand for the fruit as dessert and a half peach made a service which looked small and two pieces were more than the management could afford for the price. Sliced fruit in No. 10 cans more nearly satisfied the requirements. Similar packing in No. 1 cans for home use followed from the former so that this style of packing is a very important item in factory operations.

Sliced peaches for dessert need to be of the highest quality, fairly firm, clear in texture, and free from blemishes as the thinness of the pieces predispose to softening of the edges, breakage, making very slight defects apparent. Slicing of the pie grade is less particular. The sirup used is most frequently the same as for choice and standard grades in halves.

Special machines have been developed to do this work accurately and at a high rate of speed. The usual form consists of a frame within which are rotating disks spaced at equal distance on a half circle, the cutting edges of the disks nearly meeting at the axis of the circle. The number of disks used determines the thickness of the pieces.

These machines are fed by a very ingenious device. The halves are dumped upon a table from which they slide over an inclined vibrating frame which turns each piece cup downward to feed upon a belt. Flexible fingers are arranged on each side of the belt and these direct the pieces to the center in line with the cutting disks. The feeding takes place at the rate of two tons per machine per hour and some factories are provided with three or four machines, thus indicating the importance of this style of packing.

Special Packing

A few freestone yellow peaches are packed whole. These are of the smaller size, two to a No. 2 can or four or five for the double length No. 2 can. These are called Melba peaches, presumably from the famous Escoffier dessert of that name. They must be perfect fruits packed in 50 to 55 degree sirup.

Some mammoth halves, 18 to 20 to a No. 10 can, are packed for use at soft drink parlors.
Pie Fruit

Since the solid packing of apples practically revolutionized the packing of that fruit for pies, a similar process has been developed for peaches. The stock, which consists of soft fruit, small, marked, and irregular cut pieces, is run through a steam precooker in order to heat it thoroughly, as heat penetration is too slow to handle in the usual exhaust box. The fruit is carried in a thin layer on a wire or metal conveyor with steam directed against it from above and below. The machine discharges directly into No. 10 cans at the rate of 2½ tons per hour. The cans are filled without crushing the fruit, sealed, and processed at once. An agitating cooker is almost a necessity to handle this style of packing.

Crushed Fruit and Cut Fruit

This style of packing is being developed especially for the ice cream and soft drink trade. Although not new, it has received an impetus from the success of the crushed style of pineapple which has become so popular. In the preparation the halves are run through a coarse pulper, an Enterprise or similar style of machine which breaks them into fine pieces. The cut style is obtained by running the fruit through a set of knives placed at right angles to each other. The theory is that a more attractive article can be obtained by crushing or cutting the peach fresh and cooking with sirup than to make the preparation later from canned halves.

Cans Used

The peach is packed in plain tin cans and in probably more sizes than any other fruit. The bulk of the pack is in No. 2½ and No. 10 cans but there has been a very large increase in the No. 1 in particular as that seems to be taking the place of the No. 2 and is the favorite for sliced fruit. The fruit has little effect upon the container while the tin has a slight bleaching effect which in this case rather aids the appearance.

About 63 per cent of cling peaches are packed in No. 2½ cans; 22 per cent in No. 10 cans; 7.5 per cent in No. 1, and the balance in various sizes. About 55 per cent of the freestone peaches are packed in No. 2½ cans; 40 per cent in No. 10 cans, and the balance in various sizes.

Sirup and Its Relation to the Cut-out

Weight of fruit, 560 grams (20 ounces), in No. 2½ can:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>825</td>
<td>530</td>
<td>295</td>
<td>9.0</td>
</tr>
<tr>
<td>10</td>
<td>825</td>
<td>480</td>
<td>325</td>
<td>11.4</td>
</tr>
<tr>
<td>20</td>
<td>850</td>
<td>555</td>
<td>295</td>
<td>15.4</td>
</tr>
<tr>
<td>30</td>
<td>855</td>
<td>550</td>
<td>305</td>
<td>18.4</td>
</tr>
<tr>
<td>40</td>
<td>877</td>
<td>550</td>
<td>327</td>
<td>22.2</td>
</tr>
<tr>
<td>50</td>
<td>875</td>
<td>535</td>
<td>840</td>
<td>27.1</td>
</tr>
</tbody>
</table>

Average of commercial packs (Cling):

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>807</td>
<td>514</td>
<td>293</td>
<td>9.0</td>
</tr>
<tr>
<td>10</td>
<td>818</td>
<td>516</td>
<td>302</td>
<td>12.3</td>
</tr>
<tr>
<td>20</td>
<td>837</td>
<td>516</td>
<td>313</td>
<td>16.1</td>
</tr>
<tr>
<td>30</td>
<td>858</td>
<td>515</td>
<td>345</td>
<td>18.5</td>
</tr>
<tr>
<td>40</td>
<td>870</td>
<td>503</td>
<td>367</td>
<td>22.2</td>
</tr>
<tr>
<td>50</td>
<td>893</td>
<td>494</td>
<td>399</td>
<td>26.1</td>
</tr>
</tbody>
</table>
Since the foregoing experimental packs were made and record taken of commercial packing, the practice has changed and the following figures were obtained from a large number of samples in 1931.

Water grade, pounds of sugar added per case, 0, degree on cut-out sirup, 9.0; Seconds, 10 degree sirup, 1.35 sugar per case, 12 degree cut-out; Standard, 25 degree sirup, 3.75 pounds sugar per case, 16 degrees cut-out; Choice, 40 degree sirup, 7.00 pounds sugar per case, 21 degrees cut-out; Fancy, 55 degree sirup, 9.31 pounds sugar per case, and 26 degrees on the cut-out.

The average percentage of the different grades from good yellow cling peaches in central California before purchase was made upon the present specifications was: Fancy, 15; Choice, 45; Standard, 20; Seconds and Water, 15; and Pie, 5 per cent. For yellow freestone peaches: Fancy, 5; Choice, 20; Standard, 25; Seconds and Water, 30; and Pie, 20 per cent. Figures for the grades on clingstone peaches since the purchase specifications became effective are not available for the entire state but the following have been furnished by some of the largest packers: Fancy, 10; Choice, 50; Standard, 25; Seconds, 10; and Pie, 5.

It requires on an average 49 pounds of fruit per case for No. 2½ cans; 86 pounds for No. 10 cans, sirup grades; and 96 pounds for No. 10 water and pie grades. Sliced stock requires 60 pounds per case No. 1 tall cans: 54 pounds for No. 2½; 96 pounds for No. 10, sirup grades; and 113 pounds for No. 10 water and pie grades. Whole peaches require 24 pounds for No. 2½ cans and 48 pounds for No. 10 cans.

The number of persons required to pack 2,000 cases of clingstone peaches in 10 hours is about 75 cutters, 25 canners, 3 cutting forewomen, 3 canning forewomen, 5 sorters and trimmers, and 30 men to handle the fruit and machinery. A ton of fruit will yield from 42 to 46 cases, or require about 45 tons of fruit for the 2,000 cases. The waste will amount to from 33 to 36 per cent.

The number of persons required to pack 2,000 cases of freestone peaches differs from the former in that 40 cutters will suffice, the other operations being the same. This type of peach yields only 40 cases per ton so that it requires 50 tons. The waste will amount to 40 per cent.

The waste consists of pits, peel, and trimmings. The pits account for from 16 to 18 per cent, though it may go above or below this with certain varieties. In the case of hand peeling, the waste is greater than with lye peeling but there is so little of this kind done that it may be disregarded.

The pits are dried and burned or they may be dried and shipped abroad to be manufactured into oil and the shell converted into carbon. The oil appears on the market as almond oil.

Cull fruits are practically waste as about the only use that can be made of them is to convert them into alcohol and the sugar content is too low to make that profitable.

Troubles

The principal troubles encountered in canning peaches are: First, browning, due to long exposure to the air, after cutting or peeling, to the action of too strong lye, to keeping in cool lye for too long a time so that it penetrates into the tissue and cannot be washed out. The remedy is to give a quick blanch, one-half to one minute at 175°, so as to arrest the action of
the oxidase at the surface and to get the peaches into the exhaust box as soon as possible after filling the can. Any peach will brown slightly but the color disappears upon heating, unless the color has become pronounced, when it will persist in the can. Cruess has determined that discoloration is more pronounced in green than in ripe fruit and in the early season crops than in the late. Second pink coloration, from over-cooking or to not cooling after cooking. The same trouble may occur from storage where the goods are warm, as near a steampipe, the means for correcting it being obvious.

Composition

The composition of the peach as expressed by a chemical analysis gives little to indicate why it should be so popular. The figures given in Circular No. 50, U. S. Department of Agriculture, are as follows:

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Whole Fruit Per Cent</th>
<th>Juice Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>12.</td>
<td>0.0</td>
</tr>
<tr>
<td>Water</td>
<td>86.9</td>
<td>86.5</td>
</tr>
<tr>
<td>Protein</td>
<td>.5</td>
<td>.2</td>
</tr>
<tr>
<td>Fat</td>
<td>.1</td>
<td>.0</td>
</tr>
<tr>
<td>Ash</td>
<td>.47</td>
<td>5</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>12.</td>
<td>12.8</td>
</tr>
<tr>
<td>Fiber</td>
<td>.6</td>
<td>0</td>
</tr>
<tr>
<td>Sugar</td>
<td>8.78</td>
<td>11.8</td>
</tr>
<tr>
<td>Acid as malic</td>
<td>.64</td>
<td>.56</td>
</tr>
<tr>
<td>Fuel value per 100 grams</td>
<td>50.9</td>
<td>52</td>
</tr>
<tr>
<td>Fuel value per pound</td>
<td>200</td>
<td>235</td>
</tr>
</tbody>
</table>

Standards, California

**Yellow Cling Peaches**:

Fancy Grade—Fruit to be of very high color, ripe yet not mushy, and free from blemishes serious for the grade, halves uniform in size and very symmetrical. Sirup, 55% sugar when packed.

Choice Grade—Fruit to be of high color, ripe yet not mushy, and free from blemishes serious for the grade, halves uniform in size and symmetrical. Sirup, 40% sugar when packed.

Standard Grade—Fruit to be reasonably good color and reasonably free from blemishes serious for the grade, halves reasonably uniform in size, color, and degree of ripeness, and reasonably symmetrical. Sirup, 25% sugar when packed.

Seconds Grade—Trade designation “Seconds.” Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size, color, and degree of ripeness. In sirup, 10% sugar when packed.

Packed in water—Trade designation “Water.” Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size, color, and degree of ripeness.

Packed for bakery use—Wholesome fruit unsuited for above grades.

Trade designation “Pie”—Minimum drained weight 76 ounces in No. 10 can.

Trade designation “Solid Pack Pie”—Minimum drained weight 92 ounces.

**Sliced Yellow Cling Peaches**:

Fancy Grade—Fruit to be of very high color, ripe yet not mushy, and
free from blemishes serious for the grade, slices uniform in size and very symmetrical. Sirup, 55% sugar when packed.

Choice Grade—Fruit to be of high color, ripe yet not mushy, and free from blemishes serious for the grade, slices uniform in size and symmetrical. Sirup, 40% sugar when packed.

Standard Grade—Fruit to be of reasonably good color and reasonably free from blemishes serious for the grade, slices reasonably uniform in size, color, and degree of ripeness, and reasonably symmetrical. Sirup, 25% sugar when packed.

Seconds Grade—Trade designation “Seconds.” Fruit to be tolerably free from blemishes serious for the grade, slices tolerably uniform in size, color, and degree of ripeness. In sirup, 10% sugar when packed.

Packed in water—Trade designation “Water.” Fruit to be tolerably free from blemishes serious for the grade, slices tolerably uniform in size, color, and degree of ripeness.

Packed for bakery use—Wholesome fruit unsuited for above grades. Trade designation “Pie”: Minimum drained weight 76 ounces for No. 10 can. Trade designation “Solid Pack Pie”: Minimum drained weight 92 ounces for No. 10 can.

YELLOW FREE PEACHES:

Fancy Grade—Fruit to be of very high color, ripe yet retaining its form and free from blemishes serious for the grade, halves uniform in size and very symmetrical. Sirup, 55% sugar when packed.

Choice Grade—Fruit to be of high color, ripe yet retaining its form and free from blemishes serious for the grade, halves uniform in size and symmetrical. Sirup, 40% sugar when packed.

Standard Grade—Fruit to be of reasonably good color and reasonably free from blemishes serious for the grade, halves reasonably uniform in size, color, and degree of ripeness, and reasonably symmetrical. Sirup, 25% sugar when packed.

Seconds Grade—Trade designation “Seconds.” Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size, color, and degree of ripeness. In sirup, 10% sugar when packed.

Packed for bakery use—Wholesome fruit unsuited for above grades. Trade designation “Pie”: Minimum drained weight 70 ounces in No. 10 can. Trade designation “Solid Pack Pie”: Minimum drained weight 92 ounces in No. 10 can.

Maximum number of pieces per can, different sizes:

<table>
<thead>
<tr>
<th></th>
<th>3&quot;</th>
<th>3½&quot;</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fancy</td>
<td>8 oz.</td>
<td>8 oz.</td>
<td>Picnic</td>
<td>Flat</td>
<td>Tall</td>
<td>No. 2</td>
<td>No. 2½</td>
<td>No. 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>Standard</td>
<td>7</td>
<td>8</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>21</td>
<td>25</td>
<td>30</td>
<td>34</td>
<td>39</td>
</tr>
</tbody>
</table>

Minimum number of pieces per can, various sizes:

<table>
<thead>
<tr>
<th></th>
<th>3&quot;</th>
<th>3½&quot;</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 oz.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3&quot;</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3½&quot;</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8 oz.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Maximum variation in the number of pieces per can:

<table>
<thead>
<tr>
<th></th>
<th>3&quot;</th>
<th>3½&quot;</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
<th>No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fancy</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Choice</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Standard</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>
Label Weights

Fancy (Sp. Gr. 1.10) : 8Z Short, 8 ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08) : 8 Z Short, 8 ozs.; 8 Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Standard (Sp. Gr. 1.06) : 8 Z Short, 7½ ozs.; 8 Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Seconds: No. 2½, 1 lb. 12 ozs.

Water (Sp. Gr. 1.03) : Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 7 ozs.

Pie: No. 10, 6 lbs. 8 ozs.; No. 10 Solid Pack, 6 lbs. 10 ozs.

S. R. A. 20. The Use of the Terms “Lemon Cling” and “Yellow Cling” on Canned Peaches.

Replying to your request for information regarding the use of the terms “Lemon Cling” and “Yellow Cling” on canned peaches, you are informed that a declaration of the varietal name is not required upon the label. Where such a name is given, however, it must be the true name of the variety.

The Lemon Cling is a well-known variety of peach which is somewhat widely grown in California and is highly esteemed for canning. If the peaches in question, which are labeled “Lemon Cling” are not of that variety it would be obviously improper to so label them. Should the words “Yellow Cling” be substituted on the label for “Lemon Cling,” the product would be understood to belong to any one of the yellow clingstone varieties. We are informed that practically all of the peaches which are commercially canned in California are yellow-flesh clings.

S. R. A. 342. Weights of Peaches in Cans of Various Sizes

As a result of further extensive investigations it has been found that in general drained weights of canned peaches somewhat greater than those specified in Item 316, page 115, Service and Regulatory Announcements, Chemistry 24, can be attained. The drained weights named in that ruling have, therefore, been revised, as follows:

No. 1 (fruit) : 3 by 4¾ inch sanitary 10.5 ounces
No. 2 : 3½ by 4¾ inch sanitary .................................................. 13.5 ounces
No. 2½ : 4½ by 4½ inch sanitary (20 ounces) ...................................... 1 pound 4 ounces
No. 10 : 6 by 7 inch sanitary (68 ounces) ........................................... 4 pounds 4 ounces

The revised drained weight for No. 10 can does not apply to pie peaches. In view of the fact that the weight representative of properly filled No. 10 cans of pie peaches varies considerably, it is not deemed advisable to specify a definite drained weight for cans of that size. The fill of No. 10 cans of pie peaches will be judged on the appearance of the pack and the particular circumstances in each case.

The revised weights apply only to sliced peaches and peaches in halves, as did the weights given in Item 316. To determine drained weight the contents of No. 2½ cans or smaller cans should be emptied on a circular ½-inch mesh screen, 8 inches in diameter, set in a frame with a vertical side higher than the level of the product on the screen. The contents of the can should be distributed over the screen so as to form a layer of uniform depth, this being accomplished so far as possible, by the manner of emptying from the can. When necessary, peaches in halves should be turned over with the pit side down to permit draining of any liquid present in the pit cavity; this should be done in such way as to express no additional amount of liquor from the material. The period of draining should be two minutes. The method of
determining drained weight of No. 10 cans is the same as the foregoing, with the exception that a circular \( \frac{3}{4} \)-inch mesh screen, 12 inches in diameter, is used. This screen should also be set in a frame with a vertical side higher than the level of the product on the screen.

Because of variations in the character of peaches, properly filled cans may in some cases fail to yield weights as great as those specified, while in other cases these weights can and should be exceeded. Due allowance will be made where the weights announced cannot be attained. On the other hand, it is expected that weights exceeding the revised weights will be attained whenever this is possible without impairment of quality. The bureau designs to emphasize the fact that in all cases the cans should contain the greatest amount of peaches it is possible to pack in them without impairment of quality.

TENTATIVE UNITED STATES STANDARDS FOR GRADES OF CANNED YELLOW CLINGSTONE PEACHES

Effective June 24, 1935

Definition

CANNED PEACHES are the canned fruit prepared from the properly ripened fresh fruit of the peach tree (Prunus persica), by proper peeling, washing, and trimming; may be packed with or without pits; with or without sirup (sucrose), and if packed without sirup, may be packed with or without water; in hermetically sealed containers, and sterilized by heat.

TYPES OF CANNED PEACHES

Canned peaches are of two types:
- CLINGSTONE peaches are peaches having stones or pits which adhere to the flesh.
- FREESTONE peaches are peaches the flesh of which separates readily from the stones or pits.

STYLES OF CANNED YELLOW CLINGSTONE PEACHES

HALVED canned peaches are peaches prepared by peeling, cutting the peaches approximately in half along the suture, from stem to apex, with pits removed.

SLICED canned peaches are peaches prepared by peeling and slicing the halves of peaches longitudinally.

WHOLE canned peaches are whole, peeled peaches.

Grades of Canned Yellow Clingstone Peaches

(Halved or Sliced)

**U. S. Grade A** (Fancy) canned peaches are halves or slices of well ripened peaches of similar varietal characteristics; are practically uniform in color, size and symmetry; are practically free from defects; possess a firm but tender fleshy texture; a normal peach flavor; and score not less than 90 points when scored according to the scoring system outlined herein.

**U. S. Grade B** (Choice) canned peaches are halves or slices, of well ripened peaches of similar varietal characteristics; are reasonably uniform in color, size and symmetry; are reasonably free from defects; possess a firm and reasonably tender texture; a normal peach flavor; and score not less than 75 points when scored according to the scoring system outlined herein.

**U. S. Grade C** (Standard) canned peaches are halves or slices of peaches of similar varietal characteristics, surrounded by sirup testing not less than 14° Brix; are fairly uniform in color, size and symmetry; are fairly free from defects; the texture may be variable but none of the pieces are objectionably hard or, contrariwise, mushy; possess a normal peach flavor; and score not less than 60 points when scored according to the scoring system outlined herein.

SPECIAL PACKS—Cognizance is taken of the fact that canned peaches are sometimes packed without sugar for hospital, sanitarium and other special purposes. Therefore, if yellow clingstone peaches are so packed and meet all of the requirements for either **U. S. Grade A**, **U. S. Grade B**, **U. S. Grade C**, or **U. S. Grade D**, except that sugar has not been used in their preparation, the canned peaches will be certified as of the grade to which they conform, with the additional statement,

"Unsweetened Peaches in Water"

or

"Water Pack Peaches"
Grades of Canned Yellow Clingstone Peaches Below U. S. Standard

Certificates of grade covering canned peaches of the following grades issued under the United States Warehouse Act or Farm Products Inspection Law, shall bear in the space for “Remarks” the statement,

“Below U. S. Standard—Good Food, Not High Grade”

together with the appropriate explanatory legends required under the standard for canned peaches promulgated under Section 8, Paragraph 5 of the Federal Food and Drugs Act.

**U. S. Grade D** (Seconds) canned peaches are halves or slices of peaches of similar varietal characteristics, surrounded by sirup testing less than 14° Brix; may be noticeably variable in color, size and symmetry; are fairly free from defects; possess a noticeably variable texture, and a normal peach flavor.

**U. S. Grade E** (Water Pack) canned peaches are peaches consisting of halves or slices of peaches packed in water without added sugar, which may be markedly variable in color, size and symmetry, and possess a normal peach flavor. Pathological and/or mechanical defects may be somewhat prominent, and the peaches may be markedly variable in degree of ripeness.

**U. S. Grade F** (Pie) canned peaches are peaches not suitable for the above grades, but possess a normal peach flavor. The units may be either intact or broken, packed without added sugar, and have a drained net weight of not less than 70 ounces. If designated “solid pack—pie,” the minimum drained net weight shall be not less than 92 ounces.

**Sample Grade** canned peaches are peaches which fail to meet the requirements of the foregoing grades.

**SIRUP DENSITY**—The table grades A B C D of canned peaches are usually packed in sugar (sucrose) sirup. *At time of packing,* sirup of 55° Brix density is used on *U. S. Grade A* (Fancy) canned peaches; 40° Brix on *U. S. Grade B* (Choice) canned peaches; 25° Brix on *U. S. Grade C* (Standard) canned peaches; and 10° Brix on *U. S. Grade D* (Seconds). Sirup “cut-out” requirements, however, are not incorporated in Grades A and B of the finished product as sirup as such is not a factor of grade for the purpose of these grades.

Canned peaches of Grades A and B, therefore, will be certified as to grade without regard to sirup density, but in each instance official certificate of grade will bear a notation in connection with the grade statement indicating the density of sirup found upon examination. For this purpose:

“Extra heavy sirup” means that the sirup tests 24°, or over, Brix.

“Heavy sirup” means that the sirup tests 20° to 23.9° Brix.

“Medium sirup” means that the sirup tests 14° to 19.9° Brix.

“Light sirup” means that the sirup tests 11° to 13.9° Brix.

**EXPLANATION**—As used in these grades:

“14° Brix” means that the sirup shall test 14 degrees at 68° Fahrenheit when tested with a Brix spindle, or hydrometer, calibrated at that temperature with corrections made for temperature, if necessary.

“Normal flavor” means that the product is free from objectionable or off flavors of all kinds. Canned peaches in which objectionable or off flavors are detected, if not illegal, but otherwise meet the requirements of the foregoing grades, will be graded OFF-GRADE (Substandard).

**Prerequisites to Grading**

**FILL OF CONTAINER**—Cans of peaches shall be filled to the maximum capacity consistent with the maintenance of quality. The grade will be certified “Below U. S. Standard” if the head space indicated in Table I is exceeded. A can will not be considered properly filled even though it meets the above head space requirement and/or the 60 per cent minimum “put-in” weight requirement hereinafter mentioned if more fruit could have been packed into the can without impairment of quality.

A certificate of grade covering cans of peaches having excessive head space shall bear the legend,

“Below U. S. Standard—Slack Fill”
Added liquid is considered excessive in canned peaches when the weight of fruit placed in the container is less than 60 per cent of the weight of water at 68°F Fahrenheit which the sealed container will hold when completely filled.

A certificate of grade covering canned peaches that do not meet the above requirement in that the packing medium is excessive shall bear the legend

“Below U. S. Standard—Slack Fill”
“Contains Excess Added Liquid”

**DRAINED NET WEIGHT AND HEAD SPACE REQUIREMENTS**—

Drained net weights of canned peaches are determined by emptying the contents of the can upon a circular sieve of proper diameter containing 8 meshes to the inch (0.097-inch perforations), and allowing to drain for 2 minutes. The sieve diameters used are: 8 inches for No. 3 size cans or smaller, and 12 inches for cans larger than No. 3.

The minimum drained net weight and the maximum head space allowable in the sizes commonly used in packing canned peaches are shown in Table No. I.

**TABLE No. I**

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum Capacity in Water at 68°F (ounces)</th>
<th>Minimum Drained Net Weight (ounces)</th>
<th>Maximum Head Space Allowable (measured from top of double seam) in 16ths of an inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; Buffet</td>
<td>7.93</td>
<td>7</td>
<td>7.2</td>
</tr>
<tr>
<td>3½&quot; Buffet</td>
<td>8.68</td>
<td>10½</td>
<td>8.8</td>
</tr>
<tr>
<td>Picnic</td>
<td>10.94</td>
<td>7</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>16.70</td>
<td>10½</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>13½</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 2½</td>
<td>29.79</td>
<td>20</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 3</td>
<td>35.08</td>
<td>22½</td>
<td>10.2</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>76</td>
<td>13.6</td>
</tr>
<tr>
<td>No. 10 Water Pack</td>
<td>109.43</td>
<td>92</td>
<td>13.6</td>
</tr>
</tbody>
</table>

**COUNT**—The minimum and maximum number of halves of peaches per can, and the maximum variation in the number of pieces per can shall correspond to the following table. Official certificates of grade will indicate the exact count of each can graded.

**TABLE No. II—COUNT**

<table>
<thead>
<tr>
<th>Can Size</th>
<th>U. S. Grade A Min.</th>
<th>Max.</th>
<th>Var/can</th>
<th>U. S. Grade B Min.</th>
<th>Max.</th>
<th>Var/can</th>
<th>U. S. Grade C Min.</th>
<th>Max.</th>
<th>Var/can</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; Buffet</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>3½&quot; Buffet</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Picnic</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>No. 2</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>10</td>
<td>3</td>
<td>4</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>No. 2½</td>
<td>6</td>
<td>10</td>
<td>3</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>6</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>No. 3</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>6</td>
<td>15</td>
<td>6</td>
<td>6</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>No. 10</td>
<td>18</td>
<td>40</td>
<td>14</td>
<td>18</td>
<td>50</td>
<td>18</td>
<td>18</td>
<td>76</td>
<td>22</td>
</tr>
</tbody>
</table>

**Ascertaining the Grade**

The grade of canned peaches may be ascertained by considering, in addition to the foregoing requirements, the following factors: Color, uniformity of size and symmetry, absence of defects, and character of fruit. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color</td>
<td>25</td>
</tr>
<tr>
<td>II. Uniformity of size and symmetry</td>
<td>20</td>
</tr>
<tr>
<td>III. Absence of defects</td>
<td>20</td>
</tr>
<tr>
<td>IV. Character of fruit</td>
<td>35</td>
</tr>
</tbody>
</table>

Total: 100
ASCERTAINING THE RATING OF EACH FACTOR—The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 22 to 25 means 22, 23, 24, and 25.

I. COLOR—Under the factor of color, the color typical of the variety is considered, its uniformity and its intensity. The colors found in canned peaches of the yellow clingstone type range from “Cadmium Yellow” to “Light Orange Yellow.”

Note.—The colors mentioned are according to illustrations in Ridgway’s “Color Standards and Nomenclature.”

(A) To receive a rating within the highest group, 22 to 25 points, the color of the peaches must be uniform, and contain as much yellow as found in “Cadmium Yellow” or more, and must be true to the variety. Peaches that do not meet this requirement shall not be graded above U. S. Grade B (Choice) regardless of the total score for the product.

(B) If the color is true to the natural color for the variety, ranging from “Deep Chrome” to “Cadmium Yellow,” a credit of 18 to 21 points may be allowed.

(C) If the color of the peaches varies somewhat from the uniformly bright characteristic color for the variety, ranging from “Cadmium Yellow” to “Light Orange Yellow,” a credit of 15 to 17 points may be allowed.

(D) When the color is noticeably variable throughout the can, or is unnatural to properly matured peaches, a credit within the range of 0 to 14 points may be allowed. Peaches that fall in this classification shall not be graded above U. S. Grade D (Seconds) regardless of the total score for the product.

II. UNIFORMITY OF TYPE AND SYMMETRY—Under the factor of uniformity of size and symmetry, consideration is given to the uniformity of size of the pieces, their thickness and symmetry.

(A) To receive a rating within the highest group, 18 to 20 points, the number of halves in the can, if halved, shall not be less than the minimum number of pieces permissible in U. S. Grade A (Fancy) peaches as shown in Table II, and the pieces (halves or slices) shall be practically uniform in size and thickness, and very symmetrical. The weight of the largest half, if in halves, shall not be more than 10 per cent more than the smallest. Peaches that do not meet this requirement shall not be graded above U. S. Grade B (Choice) regardless of the total score for the product.

(B) If the number of halves conform to the requirements for U. S. Grade B (Choice) peaches as shown in Table II, and the pieces (halves or slices) are reasonably uniform in size and thickness, and are reasonably symmetrical, a credit of 15 to 17 points may be allowed. The weight of the largest half, if in halves, shall not be more than 30 per cent more than the smallest.

(C) If the number of halves conform to the requirements for U. S. Grade C (Standard) peaches, as shown in Table II, and the pieces (halves or slices) are fairly uniform in size and thickness, and are reasonably symmetrical, a credit of 12 to 14 points may be allowed.

(D) When the number of halves are less than the minimum or more than the maximum for U. S. Grade C (Standard) peaches as shown in Table II, or if the weight of the largest piece exceeds the weight of the smallest piece in the can by more than 80 per cent, or the pieces are markedly lacking in symmetry, or if sliced, the slices are extremely irregular in size and symmetry, a credit within the range of 0 to 11 points may be allowed. Peaches that fall in this classification shall not be graded above U. S. Grade D (Seconds) regardless of the total score for the product.

III. ABSENCE OF DEFECTS—The factor of absence of defects has reference to the character of workmanship in the preparation of the product, also the presence of particles of pit, peel, bruised spots, knife marks, discolorations of any kind; mechanical, physiological or pathological damage of any kind, or insect injury.

(A) If the peaches are practically free from the defects mentioned, a credit of 18 to 20 points may be allowed. Peaches that do not meet this requirement shall not be graded above U. S. Grade B (Choice) regardless of the total score for the product.
(B) If the peaches are reasonably free from such defects, a credit of 15 to 17 points may be allowed.

(C) If the peaches are fairly free from defects, a credit of 12 to 14 points may be allowed.

(D) If defects are markedly prominent, over 20 per cent of the pieces being blemished, or when foreign or extraneous substances are present, a credit within the range of 0 to 11 points may be allowed. Peaches that fall in this classification shall not be graded above U. S. Grade D (Seconds), regardless of the total score for the product.

IV. CHARACTER OF FRUIT—Under the factor of character of fruit, consideration is given to the degree of ripeness, the texture of the peaches, and their tendency to retain their original conformation and shape without material disintegration. The condition of the flesh—its firmness or tenderness—is to be noted in this connection.

(A) If the peaches are intact—not broken—firm yet very tender, thick, meaty, pliable, indicating full ripeness, possess a fine texture and well defined edges with no appreciable breaking down of the flesh, a credit of 32 to 35 points may be allowed. Fruit of this character may be handled without tearing only when extreme care is used. Peaches that do not meet this requirement shall not be graded above U. S. Grade B (Choice) regardless of the total score for the product.

(B) If the peaches are firm but reasonably tender, and possess a good texture, a credit of 27 to 31 points may be allowed.

(C) If the peaches are very firm with flesh tenacious, indicating immaturity or, contrariwise, soft, being somewhat ragged or frayed, indicating full ripeness, a credit of 21 to 26 points may be allowed.

(D) When 10 per cent or more of the pieces in the can are excessively hard (failing to meet the standard promulgated under the Federal Food and Drugs Act), immature, or, contrariwise, are mushy or excessively soft, a credit within the range of 0 to 20 points may be allowed.

---

PEAR

Pyrus communis

The pear is indigenous to south central, southern, and southeastern Europe and to the Caucasus region of Asia. Its European cultivation is much older than that of the peach for a great many varieties were known to the Greeks and Romans, indicating that it had been not only cultivated for a long time but obtained from various sources. It was also known in China, probably secured in trade with the people of western Asia, but not known in India. There is no species native to this hemisphere, our supply being from importations at various times though some of the varieties were developed by local horticulturists.

The pear is closely related to the apple, being a different species of the same genus. The trees are similar in appearance, the pear being more conical with a tendency to grow somewhat taller, the leaves larger and more rigid, the flowers slightly larger, and the fruit with an elongated stem end giving the “pear shape.” The pear is not as adaptable to climatic conditions as the apple, is less certain as a crop, and more susceptible to disease or blight. While widely grown, production in quantity is limited to certain sections, the principal region for the production for the fresh market, canning and drying being on the West Coast. There are a number of varieties but the one par excellence is the Bartlett which originally came from Europe under the name Bonchretien. The Seckel is a small variety esteemed
for the making of pickles and preserves. The Kieffer is of good appearance and owing to its hardiness is the one most grown in the East.

The pear has a distinctive pleasing flavor and is generally sweeter than the apple. It has a comparatively short season, is eaten raw chiefly, only a small amount being used in cookery. Unlike most fruits, it is more esteemed when canned and then used mainly as a dessert. The pack amounts to about 4,250,000 cases annually. In France and England the juice, perry, is prepared the same as cider and is a popular beverage.

Composition

The composition of the pear as given in Circular 50, U. S. Department of Agriculture, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>All Varieties</th>
<th>Bartlett</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>17.0</td>
<td>17.5</td>
</tr>
<tr>
<td>Water</td>
<td>82.7</td>
<td>83.5</td>
</tr>
<tr>
<td>Protein</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Fat</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Ash</td>
<td>15.8</td>
<td>15.4</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Fiber</td>
<td>8.9</td>
<td>8.33</td>
</tr>
<tr>
<td>Sugars</td>
<td>29.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Acid as citric</td>
<td>69.6</td>
<td>66.8</td>
</tr>
<tr>
<td>Heat units per 100 grams</td>
<td>315.0</td>
<td>305.0</td>
</tr>
</tbody>
</table>

As previously indicated the center of the pear industry is on the West Coast where climatic conditions are the optimum for the production of fruits. They were introduced by the padres who founded the missions in southern and central California when the territory was still a part of Mexico. There was some fruit to be had at the missions when the gold rush occurred in 1849. The pear growing section extends as far north as Washington, where they are of exceptional quality, and now nearly equal in volume to those packed in the south.

The packing of pears is undergoing an evolution. In the early history of the canning of this fruit it was gathered when passing through the hard ripe stage; then it was picked a little harder and held in boxes from a few days to a week or more to await softening so that handling could be done more easily and with less danger to the fruit; this was followed by picking when still harder or in the green stage and held in cold storage from two to four weeks or even longer to slow up the rate of change; and now it is picked when hard ripe and exposed to ethylene gas to induce uniform ripening in about four days. What the final outcome may be remains to be seen. One can pretty safely predict, however, from experience with other fruits, that the flavor will not be improved by artificial methods over that developed naturally.

Picking

The fruit is picked when at the desired stage and handled in lug boxes. It is preferable that the fruit be graded as a preliminary step before going into storage either in a cellar or at reduced temperature. Either belt or roller graders handle the fruit gently and this can be done with less damage with hard ripe fruit than at a later time. By this preliminary grading the maturing of the fruit in the different lots will be more uniform and thus
may be taken out for preparation as a unit. Any cull fruit can be removed during the sorting and thus avoid storage and further handling.

The California contract requires that pears meet the general specifications of all fruits on quality and the special specifications for size. “All fruits covered by this contract shall be of good color, shape, quality, and in good condition for canning; at the state of maturity Buyer may require, free from doubles, worms, scab, frost rings, hail or rain damage, red streaks in flesh, windfalls, visible split pits, parasites, fungi, bruises, spray residue, gum or other imperfections.

“No. 1 Pears shall be 2½ inches in diameter, of a length not less than 1½ times the diameter of the pear and shall produce two perfect halves. No. 2 Pears shall be not less than 2¼ inches in diameter; and in all respects shall conform to the specifications of No. 1 Pears.”

In the more recently equipped plants, the pears are peeled directly from lug boxes and dropped upon a conveyor belt from which another group of workers take up the fruit, split and core it. Dividing the peeling and coring operations results in better workmanship. The peeling and coring have always been hand operations, special knives being developed for the purpose. The peeling knife has a curved blade, with a guard to regulate the depth of the cut. The stroke is made from the stem to the blossom end and not around the fruit. The core is removed with a double curved knife, the smaller curved portion to cut out the stem and blossom end and the larger curve to remove the seed cells.

The peeling naturally reduces the size of the fruit so that some packers prefer to have the grading or sizing done after peeling as it secures somewhat greater uniformity. A rubber tubular spreading belt has been developed for this purpose and is interposed in the line between the peelers and splitters.

The pear is split lengthwise through the center or as nearly as possible in order to have perfect halves. Those who become skilled in handling the coring knives do the cutting with speed and uniformity as to the amount of material removed.

Numerous attempts have been made to develop machines to do the peeling and coring. The apple peeler is unsatisfactory as the blade will not follow the contour evenly and in making a transverse cut does not leave a perfectly smooth surface. The abrasion peeler removes too much at some places and too little at others, and heating the skin by either hot water or steam and then brushing the surface gives an uneven and fuzzy effect. During the seasons of 1934 and 1935, three special machines were developed which are a vast improvement over anything which had preceded and are so nearly perfect that many have been put into use.

Lye peeling is frequently mentioned in connection with the peeling of pears, but has never been a commercial success. This has been revived by a patent No. 1,895,102, January 24, 1933, granted to George Mayhew, Collingwood, Victoria, Australia. The important part is stated in the following paragraphs:

According to the invention, the pears or other fruit are immersed in a scalding bath of water, lime and caustic soda. The lime is preferable newly burnt or quicklime and may be in such quantity as to form either a complete solution in water or a suspension therein. The quantity of lime ordinarily exceeds the amount of caustic soda, and the
proportion of the former may be from five to ten times that of the latter. In one practical example, I use five pounds of lime and one pound of caustic soda to every twenty gallons of water. The mixture is heated to scalding temperature preferably by the use of steam.

The period of the immersion of the fruit depends upon the variety and degree of ripeness of the fruit, the toughness of the skins and other conditions, but for pears less than sixty seconds is usually found to be sufficient. The action of the bath causes expansion of the immersed fruit to take place. The caustic soda has a destructive action on the fibers of the skins, and the lime functions as a filler for the expanded pores of the skins.

The fruits when removed from the first treatment bath of scalding temperature are immersed in a second bath consisting of cold water, the effect of which is to cause contraction of the fruit flesh and the fruit skin. The fruit flesh contracts to a greater extent than does the skin having the lime filler in the pores thereof, so that the fruit when removed from the said second bath is found to have its skin loosened or separated from the fruit flesh by reason of the varying degrees of concentration. The loosened skin is subsequently removed cleanly and readily by subjecting the fruit to the action of a jet or jets of water.

Mechanical means may be provided for automatically depositing the fruit into the first bath, removing it therefrom and depositing it into the second bath, and for removing it from the latter bath and feeding it to an appliance equipped with a water jet or jets.

The peeled fruit is conveyed to bins on the canning tables and kept submerged in a 3 per cent brine during the short time it is being handled.

In filling the cans, particular attention is given to the selection of perfect halves, even in size, color, and texture. The irregularity in the shape of the pieces makes filling a particular job to get evenness and a good appearance in the arrangement so that the work is delegated to certain skilled workers rather than trusting to any help that might be available. The correct weight must be obtained and at the same time have nearly a uniform number of pieces. The schedule for the different grades is attached at the end of the section.

Those who do the peeling and coring usually make some separation for soft and hard fruit but the fillers must make further selection and also

A LATE TYPE OF PEAR PEELING MACHINE
catch any spots, improperly trimmed, and irregular pieces due to poor
cutting and see that they are segregated in the proper grades.

The handling between the peeling, filling the can, and siruping needs to
take place with the minimum of delay as oxidation proceeds with rapidity.
The salt will delay action, but the clean bright color desired in the finished
product can only be obtained by speeding the operations.

Pears have less acidity than most fruits and therefore are not in need
of a heavy sirup. The flavor is delicate and easily masked by too much
sweetness. Some of the fancy fruit is injured by excess sugar in catering
to the imagined whims of the trade, which in the final analysis are created
by the packer.

Exhausting and Cooking

Pears have little action upon a metal container and ordinarily are packed
in plain rather than lacquer-lined tins. Nevertheless, they need a long low
exhaust, 10 to 12 minutes at 175° F. to free them of gas. A short hot ex¬
haust is almost certain to cause pitting of the surface and more or less
sloughing on pieces which project above the sirup. It also has a tendency
to produce a dead white or chalky appearance. When properly exhausted,
the pear should have a light clear color with a semi-translucent effect which
persists in the finished product.

The pear is easily sterilized considering its low acidity, a cook of from
12 to 20 minutes sufficing for a No. 2½ can and from 20 to 30 minutes
for a No. 10 can. The time is determined in most instances by the condition
of the fruit with respect to its physical appearance. The schedule for cook¬
ing as followed in Oregon and given by Wiegand is as follows:

<table>
<thead>
<tr>
<th>Size of Can</th>
<th>Cooking Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 tall</td>
<td>10 to 15 minutes</td>
</tr>
<tr>
<td>No. 2 tall</td>
<td>15 to 20 minutes</td>
</tr>
<tr>
<td>No. 2½</td>
<td>18 to 22 minutes</td>
</tr>
<tr>
<td>No. 10</td>
<td>20 to 35 minutes</td>
</tr>
</tbody>
</table>

It is necessary to exercise care not to cook too much and also to cool
promptly to near atmospheric temperature. Partial cooling and stacking
while warm results in a dull appearance. Cooking too long or stacking
without cooling may result in a pink discoloration, a defect the cause of
which was first determined in 1878. A similar though much more irregular
discoloration results from the use of immature fruit or windfalls.

The cans used are about 50 per cent No. 2½; 20 per cent No. 10; 12
per cent No. 1 tall, and the remainder divided.

Considerable quantities of pears are packed for fruit salad in which
event they may be cut into quarters or sixths, if of large size.

Whole Pears

A few pears are packed whole for a special trade. These are selected for
evenness of size and symmetry, are carefully peeled, and the stems scraped
and cut to a length of about ½ inch. The pears generally used are medium
or small in size in preference to the large.

The amount of sugar used per case for the various grades in 1930 was
about as follows: Water, none; Seconds, 1.35 pounds; Standard, 4 pounds;
Choice, 5.40 pounds; and Fancy, 7.20 pounds.
Effect of Varying Degrees of Sirup on Pears, Weight of Cut-out of Fruit and Sirup

Weight of fruit used, 500 grams (20 ounces) to a No. 2½ can:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>825</td>
<td>562</td>
<td>263</td>
<td>11.</td>
</tr>
<tr>
<td>10</td>
<td>837</td>
<td>565</td>
<td>272</td>
<td>13.6</td>
</tr>
<tr>
<td>20</td>
<td>850</td>
<td>538</td>
<td>312</td>
<td>16.5</td>
</tr>
<tr>
<td>30</td>
<td>857</td>
<td>544</td>
<td>313</td>
<td>20.5</td>
</tr>
<tr>
<td>40</td>
<td>887</td>
<td>577</td>
<td>310</td>
<td>24.</td>
</tr>
<tr>
<td>50</td>
<td>900</td>
<td>548</td>
<td>352</td>
<td>27.2</td>
</tr>
<tr>
<td>60</td>
<td>915</td>
<td>565</td>
<td>350</td>
<td>31.</td>
</tr>
</tbody>
</table>

Commercially packed pears, No. 2½ cans, same season:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>811</td>
<td>501</td>
<td>310</td>
<td>9.3</td>
</tr>
<tr>
<td>Seconds</td>
<td>829</td>
<td>511</td>
<td>318</td>
<td>12.9</td>
</tr>
<tr>
<td>Standard</td>
<td>841</td>
<td>531</td>
<td>310</td>
<td>16.6</td>
</tr>
<tr>
<td>Choice</td>
<td>875</td>
<td>531</td>
<td>339</td>
<td>17.9</td>
</tr>
<tr>
<td>Fancy</td>
<td>865</td>
<td>518</td>
<td>346</td>
<td>21.1</td>
</tr>
</tbody>
</table>

Pint Jar:

<table>
<thead>
<tr>
<th>Density of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>559</td>
<td>345</td>
<td>214</td>
<td>5.9</td>
</tr>
<tr>
<td>10</td>
<td>566</td>
<td>358</td>
<td>208</td>
<td>10.9</td>
</tr>
<tr>
<td>20</td>
<td>579</td>
<td>360</td>
<td>211</td>
<td>15.2</td>
</tr>
<tr>
<td>30</td>
<td>601</td>
<td>366</td>
<td>235</td>
<td>20.3</td>
</tr>
<tr>
<td>40</td>
<td>605</td>
<td>345</td>
<td>260</td>
<td>26.0</td>
</tr>
</tbody>
</table>

Baked Pears

Baked pears have some popularity in season and furnish a means of using some of the harder or winter varieties. In experiments reported upon baking, the pears were mounted on pegs held in trays and subjected to a temperature of 450° F. until softened which requires from 25 to 45 minutes. In preparing the pears for baking, they are washed but not peeled and, when cooked, are packed in sirup. They are then cooked in the cans in the regular way but the time may be reduced if the baking has been carried to the point of softening the tissue to the core.

Standards (California No. 2½ Can)

Fancy Grade—Count: Not less than 6, not more than 12 pieces. No single parcel should vary more than 4 pieces per can. Description: Fruit to be of very fine color, ripe, yet not mushy, and free from blemishes serious for the grade; halves uniform in size and very symmetrical. Sirup: Percentage of sugar when packed, 40.

Choice Grade—Count: Not less than 6, not more than 15 pieces. No single parcel should vary more than 5 pieces per can. Description: Fruit to be of fine color, ripe, yet not mushy, and free from blemishes serious for the grade; halves uniform in size and symmetrical. Sirup: Percentage of sugar when packed, 30.

Standard Grade—Count: Not less than 6, not more than 21 pieces. No single parcel should vary more than 6 pieces per can. Description: Fruit to be reasonably good color, ripe, but yet not mushy, and reasonably free from blemishes serious for the grade, halves uniform in size and reasonably symmetrical. Sirup: Percentage of sugar when packed, 20.
Second Grade—Count: No size limits. Trade designation “Seconds.”
Description: Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size. Sirup: Percentage of sugar when packed, 10.

Packed in Water—Trade designation “Water.” Fruit to be tolerably free from blemishes serious for the grade, halves tolerably uniform in size.

Packed for Bakery Use—Wholesome fruit unsuited for above grades. Trade designation “Pie”; minimum drained weight 70 ounces for No. 10 can.

Trade designation “Solid Pack Pie”: Minimum drained weight 92 ounces for No. 10 can.

Maximum number of pieces per can, various sizes:

<table>
<thead>
<tr>
<th>Size</th>
<th>Fancy</th>
<th>Choice</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>8 oz.</td>
<td>8 oz.</td>
<td>8 oz.</td>
</tr>
<tr>
<td>3½&quot;</td>
<td>Picnic</td>
<td>Tall</td>
<td>No. 1</td>
</tr>
<tr>
<td></td>
<td>No. 2</td>
<td>No. 2½</td>
<td>No. 3</td>
</tr>
<tr>
<td></td>
<td>No. 1</td>
<td>No. 1</td>
<td></td>
</tr>
</tbody>
</table>

Minimum number of pieces per can, various sizes:

<table>
<thead>
<tr>
<th>Size</th>
<th>Fancy</th>
<th>Choice</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>8 oz.</td>
<td>8 oz.</td>
<td>8 oz.</td>
</tr>
<tr>
<td>3½&quot;</td>
<td>Picnic</td>
<td>Tall</td>
<td>No. 1</td>
</tr>
<tr>
<td></td>
<td>No. 2</td>
<td>No. 2½</td>
<td>No. 3</td>
</tr>
<tr>
<td></td>
<td>No. 1</td>
<td>No. 1</td>
<td></td>
</tr>
</tbody>
</table>

Variation tolerated in the number of pieces per can:

<table>
<thead>
<tr>
<th>Size</th>
<th>Fancy</th>
<th>Choice</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>8 oz.</td>
<td>8 oz.</td>
<td>8 oz.</td>
</tr>
<tr>
<td>3½&quot;</td>
<td>Picnic</td>
<td>Tall</td>
<td>No. 1</td>
</tr>
<tr>
<td></td>
<td>No. 2</td>
<td>No. 2½</td>
<td>No. 3</td>
</tr>
<tr>
<td></td>
<td>No. 1</td>
<td>No. 1</td>
<td></td>
</tr>
</tbody>
</table>

Label Weights

Fancy (Sp. Gr. 1.08): 8Z Short, 8 ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Choice (Sp. Gr. 1.06): 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Standard (Sp. Gr. 1.05): Same weights as Choice except No. 300, 14½ ozs.; No. 10, 6 lbs. 9 ozs.

Seconds: No. 2½, 1 lb. 12 ozs.

Water (Sp. Gr. 1.02): No. 2½, 1 lb. 12 ozs.; No. 10, 6 lbs. 6 ozs.

General Considerations

A good crop in central California yields fruit which packs on an average: Fancy, 20; choice, 40; standard, 25; seconds and water, 10; and pie, 5 per cent.

There are required on an average 50 pounds of good fruit per case for No. 1 Picnic cans; 60 pounds for No. 1 tall cans; 52 pounds for No. 2½ cans; 96 pounds for No. 10 cans of the sirup grades; and 101 pounds for No. 10 cans, water grades.

The number of persons required to pack 2,000 cases in a ten-hour day

APPERTIZING
are approximately as follows: 200 cutters, 50 canners, 10 cutting fore¬
women, 6 canning forewomen, and 45 men to handle the machinery and
fruit through the factory. The yield will be about 37 cases per ton and the
waste approximately 45 per cent. At present little use is made of the waste
though it probably has sufficient food value to justify drying for stock.

PINEAPPLE

Ananas sativus

The pineapple has the unique distinction of being the only New World
product which entered the family of fruits as a regal member with undis¬
puted title. Before it was seen in Europe or in any other part of the world
it was heralded through the most lavish laudations by adventurers return¬
ing to their native land, and when the fruit arrived on the continent, it
was given the place of honor on the royal table, and the plants provided a
home in the princely gardens. More could not have been done in according
to it a generous and aristocratic reception.

The plant, a native of Brazil and probably of other parts of South and
Central America, was brought promptly from the mainland to the West
Indies and cultivated by the Spaniards as soon as they learned of its quali¬
ties. It was carried to other tropical countries by the early navigators and
was even well established in the Orient by the 17th century. Not any other
fruit is known to have been so widely distributed in so short a time, and
this is the more remarkable when one considers that it is propagated only
by cuttings, suckers, or plants and not by seeds, that navigation was slow,
the vessels small so that every cubic foot of space was needed, and the
undertakings hazardous. Now, after four centuries, it is being made the
subject of intensive study, both culturally in the field and in the method of
preservation of the fruit, in a new home three thousand miles distant in
the Pacific. And, as in its early state, it retains its prestige as something to
be sought because of its excellence. The story of its progressive introd uc¬
tion into alien countries is told interestingly in the extracts from the ac¬
counts of the early explorers and writers.

Pigafetta the First to Mention the Fruit

The pineapple is mentioned for the first time by Antonio Pigafetta who
accompanied Magellan on his memorable voyage in 1519.* The reference
in his manuscript is as follows:

“It (Brazil) is the land extending from cape of Santo Augustino, which
lies in 8 degrees of the same pole. There we got a plentiful refreshment of
fowls, potatoes (batate), many sweet pine-apples—in truth the most deli¬
cious fruit that can be found—the flesh of the anta, which resembles beeff,
sugarcane, and innumerable other things, which I shall not mention in
order not to be prolix. For one fish-hook or one knife, these people gave
5 or 6 chickens; for one comb, a brace of geese; for one mirror or one pair
of scissors, as many fish as would be sufficient for x men; for a bell or one

* Pigafetta, Antonio. “Le voyage et navigation fait par les Espagnolz es Isles de Mollucoques,”
Paris, 1525. A complete translation of the Ambrosian MS. was made recently, 1906, by James
Alexander Robertson under the following title: Magellan’s voyage around the world by Antonio
Pigafetta.
leather-lace, one basketful of potatoes (batate). These potatoes resemble chestnuts in taste, and are as long as turnips."

**Account of Hernandez de Oviedo**

Hernandez de Oviedo, governor of San Domingo, gave the first account of the plant and fruit, accompanied by a drawing. His description, or rather rhapsody, though lacking some of the technique of the modern botanist, is sufficiently fulsome respecting the qualities of the fruit to satisfy the most modern advertising engineer, and the nearly literal translation is worthy of reproduction in full.*

“There are in this Spanish island some thistles, every one of which has a pine that is one of the most beautiful fruits that I have ever seen in any part of the world I have visited; at least in Spain, France, England, Germany, even in all Italy, or on the estates of his imperial majesty of Burgundy, in Flanders, Tyrol, Zirtues, Holland, Zealand, nor in Sicily, though they have peaches, pears, and all those fruits that King Ferdinand I, with royal desire, accumulated in his gardens and inclosed park at Naples, nor in the newly broken lands of the Duke Ercoles of Ferrara close to the northern isle of the Po, nor in the sunken vegetable gardens of the Señor Ludovico, Duke of Milan, in which are cultivated the full grown fruit trees on the mesa and its inclosures. No mature fruit I have known or seen in all the places I have mentioned or have been, nor do I imagine that in all the market places of the world any other combines such qualities to please or to equal it. Its beauty to the sight, delicacy of scent, and fullness of excellent savor appeal to three of the five senses. And even the fourth, that of touch, participates in a superior degree above all the fruits and foods in the world. Why omit that of hearing? The fruit cannot hear or listen. But the reader in his place can listen with attention to what is said of the fruit and can see that I am not deceiving in what I say of it.

“He who sees, smells, tastes, or touches these pines will justly give preeminence to them over all other fruits considering all four senses or aforesaid particularities, nor can tongue give so minutely an account or picture the fruit as to satisfy all who wish to go into the details in the case. And why should I not likewise select other words, if I know how to do it, that might in some manner portray as those titles on the margin, the reality, so that the delightful sight be enjoyed by all. Since not having colors it will lack greatly in the delineation and not convey a complete understanding as the matter deserves. But leaving the picture aside that concerns solely the appearance, and this to my eyes is the most beautiful of fruits, graduated in colors from green and luminous or variegated with very strong yellow, and as it ripens becomes bright yellow, losing the green. In the same manner is augmented the odor that of a very fine and flawless peach associated amply with that of the quince. And one piece in a house scents the chamber in the manner I have said. The flavor is better than the peach, more fumy; and trimmed roundabout and round slices made, or as one wishes the cut, a piece on each side lengthwise at right angles to the base, make handsome sections.

“In all these islands the fruit is like I have said and very common and also on the mainland, and as the Indies have many and divers tongues, so

---

there are numerous names for it. In 20 or 30 leagues there are at least 40 or 50 languages and this is one of the principal reasons why few Christians remain among those barbarous people. We shall give this in its place and return to the fruit of the pine. It is the name the Christians gave them for they appear like it in some way but these are handsomer and do not have the robustness of the pine cone or of the Castilian nut pine for those are wood or almost so and these others are cut with a spoon like a melon or in round slices, preferably removing the outer rind that is like raised fish scales, that make them appear like pine cones. But these are not open nor divided at the joints like the scales of the pine kernels. Indeed, as among the birds, or the plumes as seen in the peacocks of our Europe, nature brightens with the same care, the composition and beauty of this fruit, more than in any of all those that I have seen, and I cannot conceive that in all the world there is any other so complete. One alone of these fruits of pine smells more than peaches, Persian peaches, and quince stewed together and much better than all three odors emitted from them. It is a fumy fruit and has a fine and pleasing fleshiness to the taste. They are as large as medium-sized melons, some larger and others much smaller. That is the reason that not all fruits of pine, though of the same appearance, are of the same species or savor. Some are somewhat sharp, through being poorly cultivated or grown in unsuitable soil, or as in all fruits it happens that one melon is better than another, one pear better than another, and so with the rest. And consequently one fruit of pine has great preference over another, but there is no comparison of the good ones with other fruits that I have seen. Although I believe that other men may not agree with me, for in Spain and other parts of the world some contend that the figs are better than the pears, and others that the quince is better than the peach, and the pear, and figs, and others that the grapes are better than the melons and others named, and so on with the matter, each one is inclined to his taste and thinks that what he says he feels should not be discredited. But aside from inclinations and palate associations, which undoubtedly are as different as the faces of men are from one another, and without personal feelings, I think that the majority will be of my opinion upon this fruit rather than with another.

"The pine springs from a thistle, rough and spiny, with long pulpy leaves and very wild, and from the middle of the thistle comes a round stalk that sends out a single pine, which matures slowly in ten months or a year and cutting the thistles does not cause it to yield more fruit nor perform any function except to cumber the land. Being able to say that since it is a thistle that yields this fruit, why not call it artichoke? I say that it was through the early Christians who saw them here calling them pinas, though they could more justly call them artichokes, having regard to the thistle from which they issue, but these had no spines,* and appeared more like the pine than the artichoke. True it is that it is not entirely separated from the race of the artichoke nor from the pines, for the crown or summit of the pine has a sharp top that beautifies it greatly in appearance; some have one, two, or more such tops where the fruit is joined with the stem of the thistle or where it rises, and in order to plant other thistles and pines,

---

*This description, "but these had no spines," is construed by one of the closest students of the pineapple to indicate a strain that was the forerunner of the Smooth Cayenne rather than that the latter had its origin in a greenhouse culture.
these tops are the seed or succession of this fruit. For they take the top that
the pine has above the fruit or those that are united with it at the peak and
plant them in the soil two or three fingers in depth, half the top exposed;
presently it takes root well and in the course of time, as I have said, every
top forms another similar thistle and another pine fruit. The leaves of this
thistle undoubtedly resemble somewhat those of the false cauiras except
that they are longer and not so pleasing nor fleshy. This plant should be in
more esteem but there is not sufficient quantity of pines. But those from
the mainland I consider better and larger than those of the islands. This
fruit is not held since it completes ripening in from 15 to 20 days during
which it is very good and then rots and loses in esteem. It is very good,
though some blame it for passion. I do not know it for certain, but I know
it awaketh the appetite, and in many that for loathing or cannot eat, it
restores in them the desire for food and gives them spirit or will, strengthen¬
ing them to eat and thus restore the sensation of taste. Its savour is more
certain, or at most it resembles the peach that also has the scent of the
quince; but this savour in the pine fruit also has mingled with it that of a
compound of muscat and therefore is better than the peach. It has only
one defect and that is some wine, though it be the best in the world, none
better known, if drunk after partaking of the pineapple does not please
all tastes; just as one should know what pears are fit for roasting or other
things or the effect of drinking water after the pine, so friends of the wine
need to know the savours which will blend and I believe that this is the cause
why the fruit is not so well liked as some others. What seems to some as a
defect and a great objection seems to me a great and excellent privilege so
as to give it to the loquacious and friends of the drink. As I said the flesh
of the pines have slender filaments like the fleshy leaves of some plants
and the thistles that are eaten in Spain but more hidden to the palate and of
less inconvenience or trouble in eating it, but because of that not so useful
to the gums or teeth. On the mainland in some parts of the Indies they
make wine of these pines that I have drunk and consider it wholesome, but
it does not appear to me to have so much piquancy as the orange; for it is
very sweet and no Spaniard nor even Indian would enjoy drinking it, and
Castile, though in Spain and having well known wines, does not know it.

I shall tell of the aforesaid that these pines are of different species and
so they are in fact of many forms; some they call Yama, others Boniama,
and still other Yayaqua. These last are sometimes sharp and rough and
inside are white and vinous; those called Boniama are white inside but
sweet and somewhat fibrous. Those called Yama are somewhat elon¬
gated and the shape given here is exact, both the others are rounder, and
this last is the best of all and within is pale yellow. It is very sweet and
suave for eating and whoever has known it speaks in praise of this fruit.
In some places there are many wild ones that grow spontaneously in the
fields and in great masses; but those cultivated are better beyond compari¬
son, more delicate, and show well the benefit from cultivation.

Some have been transported to Spain, but very few last there; though
they arrive, they cannot be perfect nor good because they have been cut
green, and mature on the sea and in this form they lose their character. I
have attempted to transport them but have lost half or all the fruit from
rot due to the voyage requiring so many days. The tops also rotted. The
fruit is not adapted to this land or any other as cold as Spain. True it is
that grain is the food of this place but I have seen it do very well in my section in Madrid and I believe in a land that enjoys a fine climate warmed by the Giver as in Andalusia, though at present growing only wiry grasses in many places, there I have seen maize and because of that I am of the opinion that these pines could take the place of the thistles and in three or four months take root in these places.”

Andre Thevet

Andre Thevet, who accompanied the Spanish invaders into Peru in 1555, states that many soldiers on these expeditions became acquainted with the fruit and doubtless some carried the plants to stations on the islands and other places where they were cultivated. He gives the following information in his “Les Singularites de la France Antarctique autrement nomme Amerique,” 1559.

“The fruit which is most commonly used in their sickness is called Nana, is as large as a medium melon, round as a fir cone as can be seen in the accompanying figure. This fruit which becomes yellow on maturing, is marvelously excellent, as much for its sweetness as its savor, and is as tender and smooth as fine sugar. It is not possible to carry it from one place to another save in sweetmeats because being ripe it will not keep long. Moreover, it has no seed; wherefore certain small sprouts are planted as one would say in a graft. When ripe it is so rugged that it would peel the mouth. The leaf of this shrub, when grown, resembles a large rush.”

Jean de Lery

A much more widely disseminated account and one sometimes cited, though incorrectly, as the first in Europe, is that given by the missionary, Jean de Lery, in 1578. Being unable to find words to adequately express
his ideas of the excellence of the fruit, he declared it fit for the gods and,
as if this were not sufficient praise, he added that it should be plucked only
by the hands of a Venus.

Acosta

The English received their information concerning the pineapple at a
later date, the first apparently through a translation of "Historia natur-
elle et morale des Indes" by Acosta, in 1616. The following is from the
English translation: "The first Spaniards named many things at the Indies
with such Spanish names, as they did most resemble, as Pines, Concombres,
and Prunes, although they be very different fruits to those which are so
called in Spaine. The pines or Pine-apples, are of the same fashion and
form outwardly to those of Castille, but within they wholly differ, for they
have neither apples nor scales, but are all one flesh, which may be eaten
when the skinne is off, it is a fruite that hath an excellent smell, and is very
pleasant and delightful in taste, it is full of juyce, and of a sweet and sharpe
taste, they eat it being cut in morcells, and steeped a while in water and salt.
Some say this breedes cholera, and that the use thereof is not very health-
ful. But I have not seene any experience thereof, that might breede beleefe.
They grow one by one like a cane or stalk, which riseth among many leaves,
like to the lillie, but somewhat bigger. The apple is on the toppe of every
cane, it grows in hot and moist groundes, and the best are those in the
Islands of Barlovente. It grows not in Peru, but they carry them from the
Andes, which are neither good nor ripe. One presented one of these
Pine-apples, to the Emperor Charles the fifth, which must have cost much
paine, and care to bring it so farre, with the plant from the Indies, yet he
could not trie the taste. I have seen in new Spaine, conserves of these
Pines, which were very good."

Hans Sloane

Near the end of the seventeenth century, "The Natural History of Ja-
maica" by Hans Sloane (1689) appeared, giving a summary of what had
been said about the fruit, with the authorities, and fortunately this came at
a time when such information was wanted. The following is quoted:


"Pine-apples of Dampier. This Fruit is planted and us'd by way of
dessert (having a very nice flavour and taste) all over the hot West-Indies,
either raw, or when not yet ripe, candied, and is accounted the most deli-
cious Fruit these places, or the World affords, having the flavour of Rasp-
berries, Strawberries, &c., but they seem to me not to be so extremely
pleasant, but too sower, setting the Teeth on edge very speedily.

"The Fruit ripened by the Sun is less esteem'd than that ripen'd in a
Chamber.—Piso.

"It is clear'd of its outward Skin when ripe, and cut into slices, and so
eaten, the middle fibrous or woody part being thrown away.

"It is known when ripe by the color of the tuft of Leaves at top, which
then turn yellow, and will easily come off with the least pulling.

"This Tuft, as well as young Sprouts or Succors from the old ones on
the sides, are planted in any hot Soil, and seldom miss to prosper."
"The slices are soak’d in Canary to take off the sharpness which commonly otherways inflames the Throat, and then they are eaten. If the Wine in which they are soak’d be drank it inflames the Throat likewise—Piso. But I never found this of which Piso speaks of.

"It is a great Cordial to fainting spirits, and helps a squeamish Stomach.

"The juice is mix’d with water, and given to the sick as we give Mead.—Marcgr. It corrodes a Knife in a night if it sticks in it.—Xim. Acost.

"Piso says that the old Inhabitants of Brazil told him that this was first carried thence to Peru, and the East-Indies, and Linschotten, that they came to the East from the West-Indies.

"The juice takes spots out of Cloaths.—Piso.

"It is cold and dry, it is given to those in Fevers to cool, and excite Appetite, though apt to turn to Choler. A slice held on the Tongue quenches thirst, and moistens the Tongue.—Hernand.

"Monardes was very much out when he describes this to have Seeds to be spit out when ’tis eaten.

"The Brasilians use it in their sicknesses.—Thevet.

"It had its name from its likeness to a Pine-Apple, one was carried on its Plant to Charles V. but not lik’d. It is preserved in New Spain. They are best on the Isles.—Acosta.

"It is crowned to show its excelency, and that Crown planted gives a better Fruit than the Succors. It makes the Gums bleed. Its wine is good. It spoils after three Weeks, but recovers again.

"It is Cordial, and Stomachic, and is good in Gravel and Poisons. The distill’d water is good, but care must be had to Correct its Acrimony.—Roch.

"The Juice with Hony makes a drink in Brasile.—Morisot.

"This Plant went from the West to the East-Indies, where the Fruit is larger, and the Leaves narrower. Large and ripe Fruit was in Amsterdam Garden for five years past.—Comm. ib.

"The Conserve of this Fruit does not preserve its natural taste.—Boym."

A contemporary English work, "Vinetum Britannicum or a Treatise on Cider," contains the following paragraph:

"In Jamaica and Brasilia, grows the fruit of Ananas on a stock of a foot long, surrounded with sixteen sharp leaves, between which is the fruit like a Pine-apple, but much bigger; the innermost pulp whereof melt on the tongue, and is of so delicious a taste, that it exceeds all other dainties; of this fruit is made a Drink no way inferior to Malvasia-Wine."

More Modern History

Georges Gibault,* librarian of the National Horticultural Society of France, has given the most carefully prepared history of this fruit, especially of its introduction and use in Europe. It is from that source we obtained some of the information which follows.

"The first travellers who have left accounts on America have spoken of a delicious fruit called Nana, recalling at the time the taste of melon, strawberry, or of raspberry. Nana was the Brazilian name; in the Caribbean

---

tongue, flower or perfume, by redoubling ana-ana, perfume of perfumes. The elision of an a produces the definite name spread by the Portuguese and which is found used by Jean de Lery, French voyager, Protestant minister to Geneva, in his *Historia d’un voyage fait en la terre du Bresil, dite Amerique*, 1578. Andre Thevet described and figured the Nanas in his work, *Les Singularitez de la France antarctique autrement nomme Amerique*, published in 1558. The Milanese, Benzoni (*Histoire du Nouveau Monde*, 1565), called the fruit *Pina* from the name the Spaniards gave to it, struck by its resemblance with the cone of the Pine. The English also called the Ananas *Pine-apple, Apple of Pine*.

“In 1703, P. Plumier, taking the Ananas for the type of a new family, founded the genus Bromelia, in honor of a Swedish botanist, Olaf Bromelius.”

Naturally a new fruit of such attractive appearance and possessed of such rare edible qualities attributed to this one would have a high value, and many attempts were made to send the fruit to the mother country. The handicaps were the long sailing time, slight resistance to decay when ripe, absence of seed to start new plants, and lack of facilities for growing the plants when they did arrive. Oviedo did succeed in sending a few fruit to Spain, one of which was presented to the king. In 1559, Dutch voyagers brought the preserved fruit and possibly plants in pots from Java, showing that the plants had been successfully introduced into that country. Acosta records that plants were sent from Santa Cruz to Oriental India and from there to China, and while the exact date is not given, it must have been before 1616. No definite progress was made in introducing the plant into Europe until near the end of the 17th century, again by the Dutch who discovered how to handle the plant. Credit is claimed by the French for a refugee by the name of Le Court or Lacour, engaged in horticulture near Leyden, for the accomplishment of the difficult task. He translated a treatise on Holland gardening by Grout under the title *Les Agreruents de la campagne*, in which is described the method of forcing Ananas. It is believed he obtained his material from the Antilles and that he made many attempts before he succeeded. The outstanding Dutch gardener of the time was Bentinck, who doubtless supplied the Royal Gardens in England from the same source. The cold winters and lack of anything like adequate heating of plant-houses made an occasional fruit an object of the greatest interest.

**Pineapple Culture in France**

“In France,” quoting from Gibault, “the cultivation began in the kitchen garden of Versailles, or else at the royal palace of Choisy-le-Roi. King Louis XV, who was greatly interested in gardening, received in 1730, probably from Jesuit missionaries, two suckers of Ananas, which he intrusted to Leonard fils, director of the royal cultures. This new plant produced two fruits in 1733 which attracted the attention of the curious. The king tried one of these the 28th of December and found it very good (Pluche, *Spectacle de la nature*, 1735, t. II, p. 211).

“The culture having succeeded, it was established in the kitchen garden at Versailles according to the account of the building by the king of special hot-houses for Ananas in 1738, and later in 1752. In the middle of the 18th century are cited great houses where the culture was made on a large scale,
among others that of the Duke of Luxembourg. Mercier said in 1782, "I have seen 4,000 pots of Ananas at the home of the Duke of Bouillon, at Navarre. On the eve of the Revolution the royal palace of Choisy-le-Roi was known for its Ananas, and Edy, chief gardener, was reputed as the most able specialist of the time."

"The revolution caused the aristocratic and costly culture of Ananas to disappear, and it was only taken up again at the re-entry of the Bourbons. Louis XVIII recalled Edy, who had preserved the traditions, to the direction of the kitchen garden at Versailles. This practitioner simplified the culture, rendering it more accessible to the average proprietor, and in addition, trained many excellent pupils, among them Gontier, the horticulturist to whom is owed the diffusion of the knowledge of Ananas culture. He founded at his own risk, a model forcing establishment at Montsouris, rue de Fontaine-Issoire, where the gardeners of all France came to be initiated into the secrets of the trade.

"Nicolas Lemon, established in 1815, rue Desnoyer, near the Barrier de Belleville, had formed the most complete collection of Ananas that existed, inasmuch as in 1834 he counted 35 varieties of which he had discovered the merits.

"The introduction by Gontier, about 1830, of the hot-water system of heating horticultural houses, favored the culture of this tropical plant which took, from this fact and the favor of the mode, a new flight. ** The culture of the pineapple in France was at its apogee between the years 1840 and 1850; a culture of great luxury be it understood, as it has never been practiced save in the gardens of princely houses and mansions, where the gardener could prepare material and have means of heating that a tropical plant requires to mature its fruit. Through the mode set for parties, it was not possible to offer a dessert decently without a fine pineapple as a triumphal piece. ** But where are the snows of yester-year? The disappearance of the pineapple as a forced fruit began with the invention of conserves by Nicolas Appert in 1804 and has continued, likewise, in proportion, as the rapidity of communication facilitated importation of exotic fruits in a fresh state."

**Pineapple Culture in England**

Pineapple growing in England followed soon after the successful attempt at growing by the Dutch gardeners, already referred to, the plants being grown in the royal gardens. The occasion of presenting the first fruit to King Charles II was considered of sufficient importance to be commemorated with a painting. An inquiry relative to this picture elicited the following reply from the secretary of the Royal Horticultural Society.

"I regret that the picture has not been in the possession of the Society for many years and that I can give you very little information regarding it. The following is an extract from 'The Book of the Royal Horticultural Society,' by Andrew Murry, published in 1863.

"On the wall of one of the rooms of the Royal Horticultural Society hangs a small water-colour drawing of the time, of which the annexed woodcut is a copy, representing Mr. Rose, His Majesty's gardener at Hampton Court, presenting the first pineapple grown in this country to Charles the Second. He is represented kneeling on one knee in the midst
of a broad walk, holding up something very different from our modern "Queen's" to a wrinkled looking old gentleman in a voluminous wig and snuff colored coat, who is attended by a couple diminutive black and tan lap-dogs. The likeness of his Majesty has been happily preserved in the woodcut.

"It bears the inscription "Drawn from the original picture in the collection of the Earl of Waldegrave, at Strawberry Hill.""

"As will be gathered from the above quotation the book contains a small woodcut of the picture.

"Unfortunately, I do not know who has the original picture which was at one time possessed by the Earl of Waldegrave, nor do I know where the Society's copy is, but I have some reason to think that both exist."

Pineapple growing was taken up by the wealthy as a hobby and became very popular, the fruit bringing fancy prices like grapes grown under similar conditions or rare flowers such as orchids. The gardeners became very expert and learned many things concerning the plant, both with respect to proper fertilization to get the best results in growth and fruit, and also about artificial pollination for the production of new varieties. Some of the recent research work has confirmed many of the observations and practices of these pioneer gardeners. The great interest in the pineapple and how it was sustained is attested by the fact that between 1770 and 1820 at least five books* were published upon its culture, and two of them in two editions. It is said that the Smooth Cayenne, the variety most prized for

*Giles, John. Ananas: a Treatise on the Pineapple, the Culture, Management, etc. 1770.
Abercrombie, John. The Hot-House Gardener on the general culture of the Pine-Apple, etc. 1789.
Griffin, William. A Treatise on the Culture of the Pineapple. 1805.
Baldwin, Thomas. The Culture of the Ananas. 1818.
canning and grown in the West Indies and Hawaii, had its origin in such hot-house culture, though it can be traced only to 1870 or a little before. A secondary effect was in the great improvement wrought in greenhouse equipment in making these houses suitable for other plants requiring heat and protection.

During the latter part of the 18th and early part of the 19th centuries, occasional fruit was brought from the Barbadoes or other islands to European seaports and capitals, though always looked upon as a luxury to be claimed by royalty or the wealthy. Importations increased with better sailing service but the fruit was not common even in seaports until about 1850.

Importations into the United States

Owing to the close proximity of Cuba, Porto Rico, and the Bahamas to this country, importations of the fruit from these places began about 1800, or shortly afterward, and increased with the population along the eastern coast. According to Shriver, who made an investigation of the industry in 1915, these importations reached their peak in 1900 when 65 boat loads of from 5,000 to 15,000 dozens each were landed in Baltimore. A considerable part of these were canned, the pack during that year amounting to between 50,000 and 75,000 cases. A much lesser quantity was landed in New York and some reshipped by rail to the center part of the state to be canned. After 1908, importations for canning purposes practically ceased except for the year 1919. The importation of fruit to be used in the fresh state continues, but on a very moderate scale due to the fact that the immature fruit is not pleasing and the mature fruit is difficult to handle without loss.

The first attempt to grow the fruit commercially in this country is said to have been made near St. Augustine, Florida, in 1850. Numerous other attempts were made later, particularly during the nineties. At one time the value of the pineapple was second only to that of the citrus fruits in the state, but the cost of production and uncertainty of the crop made it unprofitable.

Hawaii the Center of Production

The center of the pineapple industry at the present time, and since 1910, has been the Hawaiian Islands, due to natural soil and climatic conditions which favor the development of the fruit to the highest degree of perfection, combined with the fact that it is preserved when in its prime condition by canning, and in that form may be distributed to all parts of the world regardless of distance or season. Natural conditions alone did not, and could not have made pineapple growing a success as the plant had been growing there wild or with meager cultivation for many years without developing either large size or fine quality to make it desirable. It required, in addition, the genius and foresight of a most unusual character in the person of Captain John Kidwell, to recognize the combination of factors and to introduce and develop the most nearly perfect type of fruit. Nor would the commercial possibilities have been realized by a less imaginative and at the same time less practical man than Mr. James D. Dole, who has done most to foster both production and distribution of this fruit. Captain Kidwell had not only the ability to select the best fruit from every source, but also the rarer quality of being able to discard anything which was inferior, thus establishing a quality basis at the beginning of the industry
instead of through the long and tedious process of gradual elimination by many at a later date. Mr. Dole quickly appreciated the inadequacy of mechanical devices for the handling of the product and stimulated and encouraged development of machinery along this line, with the result that in no other branch of fruit or vegetable packing is there more rapid and careful preparation of the product, nor more complete utilization of the raw material in some useful form. It is rare that the work of two men so completely supplement each other as in this instance. Furthermore, their ideals have been the same, broad, to the benefit of the industry rather than the limitation of their efforts to purely selfish ends. There is a vast difference between the man or firm engaged in a business for the purpose of profit only and he or they who through study and research develop something better which they are willing to share with others. It is the possession of these characteristics which entitles these two men to more than the usual meed of credit. Others have contributed by following their example. The industry has been fortunate, likewise, in that it has not been in the hands of a large number of persons with small or insufficient capital, as it could not have attained its present status under such conditions. The close contact of the large firms has forced a degree of uniformity in development and output which has been advantageous to both packers and the public.

Development in Hawaii

The history of the introduction of the pineapple into the Hawaiian Islands is obscure, being based in part upon legends and in part upon claimed records, but which are not easy of verification. The earliest accounts of the Islands or their products do not mention the pineapple though other fruits are named. The first available record is from the diary of Don Francesco Paulo y Marin, a Spanish explorer of more than ordinary talents, who came to the island in 1813. He states that he planted pineapples on January 11 of the same year, but makes no mention as to where they were obtained, whether native or brought from the mainland. He brought fruits and trees from Mexico, some of which became well distributed, and the presumption is that the pineapple was from the same source.

It is not until 1829, after the missionaries went there, that a definite statement occurs indicating that the fruit was wild. The period between 1813 and 1829 is so short that the plants could not have become numerous if they had escaped from cultivation but which would seem to indicate introduction at an earlier period. Legend has it that they were brought by a Spanish vessel that was wrecked on the Kona coast about 1527, and another that they were brought by Juan Gastaine, also a Spaniard, when he landed in 1555 and gave the Islands the name “Isles de Mesa.” The fact that the pineapples were first found in the Kona district and very sparingly or not at all in other sections seems to lend credence to their introduction at a period prior to 1800.

The Hawaiian word for the fruit is Halakahiki, the “hala” being the name of the screwpine, a tree which has some resemblance to the pineapple plant as has also the fruit, the “kahiki,” meaning foreign, indicating a foreign origin.
The Role of Captain Kidwell

The real Hawaiian pineapple industry had its inception with Captain Kidwell, a Scotchman with English training as a nurseryman. He came to the United States in 1872 and engaged in the nursery business in San Francisco in 1874. In this latter place he established business relations with different persons on the Islands and later, in 1882, he was induced to transfer his business to that place. He immediately became interested in the native plants and particularly in the pineapple which was growing without cultivation. A few fruit were even sent to the San Francisco market. They were small, rough, acid, very fibrous, in fact devoid of all the finer qualities considered distinctive and inherent to the fruit. He was familiar with the plant and also the fruit as produced in English forcing houses and knew that a vastly improved stock could be developed from the local plants through selection and cultivation, but that it would require much time. He made his first planting of Kona pines in 1885 at a point now within the suburbs of Honolulu, in the Manoa Valley of the Island of Oahu.

Keen interest stimulated his activity, and so rather than wait the slow results of his individual efforts, he sought plants from abroad and thus took advantage of what had been achieved by others. As good fortune would have it, his first selection was the Smooth Cayenne variety from Florida, though the only data upon which to make the selection was a newspaper description and advertisement. The shipment consisted of twelve plants. The second shipment consisted of a thousand plants of which six hundred grew. This lot came from Jamaica. The selection was a most fortunate one, for the variety is perfectly adapted to the conditions, producing not only large fruit but also of superior quality. Thereafter practically every promising variety (31) was imported and tested, but none has equalled the first one. Thousands of seedlings have been developed but the parent is still preëminent, though some equal or excel it in some respects.

It soon became evident that a small plantation would supply the island population, and experiments in shipping to the mainland demonstrated that the distance was too great, that spoilage and the costs of transportation absorbed any profit from the undertaking. In 1891 and 1892, he and an associate, John Emmeluth, began experimenting in canning the fruit, and these experiments were continued in succeeding years. Neither of the men knew anything about canning but they worked out a method which not only sterilized the product but also cooked it to the proper degree to make it uniformly tender but not soft. A processor, supposed to be an expert, was brought from Baltimore to help them but his knowledge was not equal to that which they had gained through their own efforts. It is a matter of record that practically no spoilage occurred in any of the fruit sent out during this experimental stage. The cans were hand-made in Honolulu and then hauled a considerable distance to the plantation. The preparation of the fruit had to be done by hand so there is little wonder that the output was limited to a few hundred cases. Captain Kidwell was a stickler for quality and through using only the best and fully ripened fruit he set a rare standard which has had an enduring effect. The first small cannery was built in 1892 and was known as the Hawaiian Fruit and Packing Company. Captain Kidwell retired from this activity in 1898 after having de-
veloped the method for canning Hawaiian pineapple, though no real export business had been established. His place in the subsequent development of fruit production was taken by Byron O. Clark, an agriculturist who came to the Islands in 1898 after the annexation of the Islands to the United States. He fostered the settlement of government land at Wahiawa and started the plantings which became the real center of the growing industry.

**Development of Commercial Canning**

The second step in the development of the packing of the fruit began when Mr. James D. Dole became a factor and devoted his energies to making it a success. He was a recent Harvard graduate attracted to the Islands in 1899 to engage in the coffee business but was disappointed in the prospects, so the following year turned his attention to truck gardening. He immediately gave attention to the growing and packing of pineapples and became convinced that large marketing opportunities were ahead if the product be properly prepared. He organized the Hawaiian Pineapple Company, Ltd., in 1901, and in 1903 built a small cannery at Wahiawa on the plantation thirty-five miles from Honolulu. The factory was equipped with the latest devices then available and the first season the total amounted to 1,893 cases. These were sold through Hunt Bros. in San Francisco and thus was launched a new industry. Operations were continued at this plant in 1904, 1905, and 1906, producing a maximum of 35,000 cases. In the meantime he saw that a factory would have to be located in the city where help was available, where supplies could be obtained, and where shipments could be received and sent out on short notice. In 1907 a new plant was erected in Honolulu, the railroad taking over the hauling of the fruit from the plantation to the factory.

The phenomenal growth which has since occurred in the industry is best told by the statistics. These are not available prior to 1903.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1903</td>
<td>1,893</td>
<td>1919</td>
<td>5,971,976</td>
</tr>
<tr>
<td>1904</td>
<td>10,304</td>
<td>1920</td>
<td>5,985,982</td>
</tr>
<tr>
<td>1905</td>
<td>44,241</td>
<td>1921</td>
<td>5,262,503</td>
</tr>
<tr>
<td>1906</td>
<td>74,245</td>
<td>1922</td>
<td>4,770,239</td>
</tr>
<tr>
<td>1907</td>
<td>168,205</td>
<td>1923</td>
<td>5,895,747</td>
</tr>
<tr>
<td>1908</td>
<td>343,726</td>
<td>1924</td>
<td>6,825,904</td>
</tr>
<tr>
<td>1909</td>
<td>401,940</td>
<td>1925</td>
<td>8,728,580</td>
</tr>
<tr>
<td>1910</td>
<td>464,968</td>
<td>1926</td>
<td>8,939,590</td>
</tr>
<tr>
<td>1911</td>
<td>725,742</td>
<td>1927</td>
<td>8,878,252</td>
</tr>
<tr>
<td>1912</td>
<td>1,318,363</td>
<td>1928</td>
<td>8,663,056</td>
</tr>
<tr>
<td>1913</td>
<td>1,667,122</td>
<td>1929</td>
<td>9,210,240</td>
</tr>
<tr>
<td>1914</td>
<td>2,268,781</td>
<td>1930</td>
<td>12,672,296</td>
</tr>
<tr>
<td>1915</td>
<td>2,669,616</td>
<td>1931</td>
<td>12,807,919</td>
</tr>
<tr>
<td>1916</td>
<td>2,609,483</td>
<td>1932</td>
<td>5,063,793</td>
</tr>
<tr>
<td>1917</td>
<td>2,607,031</td>
<td>1933</td>
<td>7,815,540</td>
</tr>
<tr>
<td>1918</td>
<td>3,847,315</td>
<td>1934</td>
<td></td>
</tr>
</tbody>
</table>

**Pineapple Canning in Other Places**

The carrying of the pineapple to the Orient—India, East Indies, and China—in the 16th and 17th centuries, seems most remarkable considering the exceedingly meager cargo facilities of the vessels and the long time required for a voyage. The great object of navigators was to reach those points so as to barter, and plants were valuable if they could be delivered
alive, among these the pineapple survived the hazards of the journey. They have been cultivated over large areas in these tropical countries but without improvement in the fruit corresponding to that in Europe and later in the western continent. Canning began in Singapore about 1890 to be followed in Siam, southern China, Dutch East Indies, and the Philippines. These are all small hand operated factories, even to making of the cans, but in spite of their limited facilities they were turning out between 600,000 and 700,000 cases annually by 1915. Comparatively little machinery has been added but the pack has increased to more than 2,000,000 cases annually though it cannot compete in the better markets with that produced on the Islands.

The introduction of the fruit into South Africa and Australia is of recent date but the exact time has not been ascertained. Canning was begun in the former country in 1913 and the latter in 1914, and in both the work is done by modern machinery adapted to the volume to be handled. There has been some canning in the West Indies and in the Bahamas but there the main effort is to supply the fresh fruit to the markets in this country and Europe. A small scale operation has also been started in different points in Mexico.

Hawaiian Islands

Since this monograph deals primarily with the commercial production and packing of pineapples in the Hawaiian Islands, it is pertinent that a brief paragraph be introduced concerning them. This group consists of numerous volcanic islands lying 2,100 miles or more south of west off the mainland in the Pacific Ocean. They stretch out to the northwest, but nearly all of the 6,400 square miles of territory is embraced within the eight larger isles that are within 400 miles of Hawaii. They lie just south of the Tropic of Cancer, thus have a warm subtropical climate with a normal rainfall which varies through a range which cannot be understood by those who have not been there. This varies with the location, from where the conditions favor condensation due to the clouds coming in contact with the northeast trade winds causing from 175 to 250 and even 500 inches of rainfall in a year, to other places protected from the moist air and in which almost desert conditions prevail. The pineapple is grown in areas receiving from 18 to 50 inches of rainfall annually but, in addition, the dews fill the base of the plant each night.

The land is rough and mountainous for the most part so that the area suitable for cultivation is decidedly restricted. The lower lands are given over to the growing of sugar cane and the upper to the pineapple, the division being based largely upon the water requirements of the two crops. The pineapple needs little water by comparison with sugar cane. The largest area given over to the pineapple is in the Island of Oahu (Honolulu), 30,000 acres, or approximately 40 per cent; Maui, 15,000 acres; Kauai, 5,000 acres; Molokai, 10,000 acres, and Lanai, 15,000 acres. This last island is sixty miles from Honolulu and is the most recent addition to the available lands. The place was nearly uninhabited, presented a most uninviting appearance with many difficulties in the way of preparing it for cultivation. However, soil analyses and growth tests demonstrated that it has the proper elements present, and capital and labor have brought the land under cultivation. The further handicap of lack of roads and a harbor
have been eliminated and a model village erected. It is of scientific interest
that pineapple culture could not have succeeded on the island except for
the use of the iron sulphate spray to supply available iron, and it is also
doubtful whether sufficient ground moisture could have been retained to
produce a crop without the use of the paper mulch.

It is of further interest that the pineapple industry has been almost co-
incident with the development of the automobile, auto truck and trailer,
and the caterpillar tractor. These labor saving devices have made large
scale production possible.

Botanical Characters

The pineapple, *Ananas sativus*, *Ananassa sativus*, or more recently
called *Ananas comosus*, is a typical tropical plant belonging to the family
Bromeliaceae. It consists of a coarse stalk about two and one-half feet in
height surrounded by many long, narrow, thick, rather rigid, more or less
spiny leaves arranged in a spiral. Both stalk and leaves are tough and
fibrous. The flowering part consists of a spike at the end of the stalk. There
are many individual, closely set, and rather insignificant, three parted,
having three each of sepals, petals, stigma lobes, and carpels, bluish perfect
flowers. The base of the flower and the separating bracts continue to de-
velop into a fleshy mass and then coalesce, thus making a multiple fruit
familiarly known as the pineapple. Each “eye” in the fruit represents a
separate flower, the flowers arranged in a spiral, and in some of the poorer
varieties the bracts remain more or less prominent or fibrous while in the
better sorts the union of parts is more complete and so nearly of the same
texture as not to be recognized except upon close examination. The fruits
vary in size from about two inches in diameter and three inches in length
to seven inches in diameter and eight inches in length, and in weight from
less than one to more than six pounds. Occasional specimens are reported
to weigh from twelve to fourteen pounds. Fortunately, seeds form only
rarely in the natural state or under the usual cultural conditions, as other-
wise the fruit would be useless. When desired, however, fertilization may
be brought about by artificial means. The fruit is more or less cone-shaped
and the eyes give the arrangement and appearance of the unopened cone
of some of the fir trees which doubtless led the Spaniards to use the prefix
*pine* as descriptive, and *apple* in its generic sense for fruit. The color is
greenish when immature, the eyes being somewhat lighter, and light red-
dish or orange when fully ripe, though this varies somewhat with the va-
riety. The stem continues to grow and thus forms a tuft of leaves or crown
above the fruit, a peculiarity which inspired someone with poetic literary
inclination to describe it thus, “The king of fruits by nature crowned.”
This is not a strictly modern appellation for Emy in *D’Art de bien faire les
Glaces d’Office*, 1768, says “the pineapple, a fruit called the king of fruits,
as much for its delicious savor which surpasses that of all those we have
known as for the kind of crown of leaves, that is placed on top, the badge
of royalty.” Only one fruit is borne on a stalk, those occurring on succeed-
ning years arise from new stalks that are in turn derived from suckers.

Reproduction in a horticultural way is obtained from “crowns” which
consist of the development of the stem beyond the fruit; from “slips”
which develop from the stalk below the fruit; from “shoots,” also called
“suckers” in the West Indies, which arise from the axils of the leaves; and
from "suckers" formerly called "ratoons" which come from the under-
ground root stem. The term "ratoon" was never used in Hawaii. Growth
is slow, requiring twenty months or more to develop the first fruit, and
about one year for those which come from the suckers. The first single
fruit is the largest, but the combined weight of the fruit from the suckers,
of which there are usually two, is in excess of the single one. If the plants
show deterioration after the second bearing period, they are uprooted at
that time. Some have three and a few a fourth crop, called ratoon crops.

The plant is very susceptible to freezing, the leaves being killed by mod-
erate frost.

A large number of horticultural varieties of the pineapple have been
developed, adapted to different conditions of soil and climate, and with
differences in resistance to local diseases and insect pests. The fruits vary
in size, shape, texture, color, acidity, sugar, and flavor. The fresh fruit
sent to this country is picked green and therefore deficient in fruit flavor
and the qualities which are characteristic of those which mature on the
plant.

The Smooth Cayenne is the variety best adapted to canning, not only
because of its fine texture and flavor, but because of being nearly cylindri-
cal, terminating rather abruptly at both ends, consequently having rela-
tively small wastage. It is grown almost exclusively in the Hawaiian
Islands but constant attempts are being made to develop a better variety
or one that may prove more resistant to disease as a precautionary measure
should some fungus or other organism be inadvertently introduced or a
local form become a menace.

Cultivation

The cultivation of the pineapple differs from that of other fruits, being
a specialty in itself, as already stated, first studied intensively in hothouse
culture in Holland, England, and France, and now the subject of the closest
scientific and practical experiments in Hawaii. The trial gardens for mak-
ing crosses, for determining soil requirements, effects of fertilizers, and
the control of insect attacks and fungous diseases are extensive and under
competent supervision. No other canning crop has been given a like
amount of attention, due in large part to the concentration of the business
in a few hands whose leaders have learned the value of co-operation in
such studies.

The growing operations are conducted upon an elaborate scale, involv-
ing thousands of acres, large equipment in tractors, plows, disking ma-
chines, harrows, cultivators, trucks, employees' camps, and a network of
truck roads and light railways to carry the fruit to the factories. The oper-
ation most nearly approaching that in this country is the growing of aspara-
gus, but this latter is on a much smaller scale. The canning companies are
the largest producers but there are some independent growers who culti-
vate small tracts either working alone or with the aid of hired help.

Any good soil with a fair water supply seems to be suitable for this plant
as it is not a gross feeder nor partial to one element. The ground is pre-
pared by thorough plowing, disking, harrowing, and floating to get it
broken finely to a good depth, smooth on top, and as free from weeds as
possible, for when once set with plants, the field cannot be changed to an-
other crop for at least four years. The ground is laid out in rows, preferably in pairs called beds, about two feet apart, and with six or seven feet between the pairs. The plants are spaced about 12 to 14 inches apart in the rows so that it takes from 12,000 to 15,000 plants per acre. The latest development is to put four rows close together with greater space between the plants in the row and thus make possible the setting of from 16,000 to 20,000 plants per acre. This procedure is used especially on acid soil. The object in having the rows in pairs or in fours is to economize space, as the plants are so rigid and spiny that room is needed for cultivation and for gathering the fruit without the necessity of coming in contact with the leaves. This can be done better by having plenty of space on one side rather than by dividing it equally. The spacing of the rows and also of the plants in the row naturally vary with the exposure and the character of the soil.

The fields are set with plants obtained by cuttings of crowns, slips, shoots, and suckers, though the last are little used in Hawaii. The shoots and suckers develop a little more quickly than the crowns and slips, but otherwise there is little choice. With all of them, the cut surface is exposed to the air for a few days to harden or form a callous as a protection against infection from the soil, a minor precaution but one of considerable importance, as prior to this practice the young plants suffered more or less injury from fungous diseases. The crowns are obtained at the time of harvesting and the other cuttings a little later. It is almost needless to add that cuttings are taken from only the strongest and healthiest plants in order to maintain or improve the stock.

**Paper Mulch**

At this point a novel feature has been introduced in the culture of this crop in the form of paper to cover the ground between the pairs of rows, the object being to keep the weeds down, to save labor, and to conserve the moisture in the soil. It has the further effect of raising the temperature and stimulating nitrate formation. The paper, known as Eckhart paper,
resembles that for roofing, being especially prepared with asphalt and made in rolls from 36 to 54 inches wide, the 36 inch width being the standard for two rows. The roll is mounted on a shaft above a sled so that it can be stretched across the field by a team. This insures straight lines. At first the paper was perforated to give a uniform spacing for the plants but this feature has been eliminated, the hole being made where wanted when the plants are set. The special paper is tough and made to withstand climatic conditions for about ten months or until the foliage is sufficiently developed to cover the space between the plants. A more durable paper was tried but discarded as having no advantages, and in fact, favored some obnoxious fungi. The Eckhart paper was first used in considerable quantity in 1920 by Hawaiian sugar planters and then adapted to pineapple culture by John Whitmore. It has proven both economical and highly advantageous and is now being adapted to truck gardening, nursery planting, and other intensive operations.

Cultivation is necessary between the pairs or sets of rows and is for the double purpose of keeping down weeds and the soil in a friable condition.

Chlorosis

In the volcanic sections where the soil is high in manganese, the plants become yellow or chlorotic, due to their inability to utilize the iron which is present, though available to most other plants. To supply this deficiency, the plants are sprayed at intervals with a weak solution of iron sulphate. This is a most unusual procedure and is one of the far-reaching results of organized experimentation. Chlorosis in the pineapple was first studied in Porto Rico in 1911, and the condition found to be due to an excess of lime in the soil, the lime preventing the plant from utilizing the iron which was present in ample quantities. Fertilizer experiments were tried but failed to correct the difficulty, but sprays of iron sulphate were effective in pot experiments. Those in charge of the work at the time did not consider it practical to use the spray in field operations and there the matter rested as an interesting scientific observation. In 1916, the spray was tried to correct the chlorosis in Hawaii and found to be successful, so practical methods for its application in the fields soon followed, in which M. O. Johnson had a prominent part. It represents the first large scale application of the principle of supplying an iron compound as a fertilizer, but instead of administering it to the soil to enter the plant through the root system, it is applied directly to the leaves. Its application is simple and is carried out by means of a power spray having long arms to reach eight rows at a time in the same manner as fungicides and insecticides are applied to garden truck. Tower spraying devices are also used, the latter delivering a fine spray high in the air and distributed over the plants by the wind. The outfit is driven along the windward side of the rows. Thus the “yellows” which at one time boded ill for the industry have been conquered by an easily applied treatment. A secondary effect is that several thousand acres of land are made available for the crop which otherwise would have been used for some other purpose.

Harvesting

The harvesting of the pineapple for canning is done when the fruit is fully ripened on the plant, or when the sugars, acids, and esters which con-
stitute flavor and bouquet, the most valuable qualities, are at their best. The fruit does not improve when once cut if it be green. The unripe fruit has a light appearance in the can and gives the impression of solidity as though a knife were necessary to cut it, whereas that which is ripe has a richer, more translucent color, and looks as though the tissue would part readily under light pressure from a spoon. The mature pineapple contains from 10 to 12 per cent of sugars and from 0.5 to 0.6 per cent of acidity as citric acid, while immature fruit contains much lesser amounts, especially of the sugars. This is explained in an abstract in the Experiment Station Record from the Hawaiian Agricultural Experiment Station Bulletin, by Wilcox and Kelly, as follows: "The stem of the pineapple serves as a repository for starch and contains large amounts of this substance. The leaves, in common with other members of the Bromeliaceae, contain several rows of palisade cells which contain nothing but cell sap, the chlorophyll is confined to the spongy parenchyma in the lower three-fifths of the leaf. The fruit contains only faint traces of starch during the early growth and none when it reaches maturity. During the growth of the fruit relatively small amounts of sugars are stored in it, but there is a rapid accumulation of sugars within the short period of normal ripening. The sugars of the fruit are derived from the starch previously stored in the stalk, hence pineapples gathered green do not develop a normal sugar content in subsequent ripening."

The fruit passes quickly from a ripe into an over-ripe condition in which fermentation takes place, consequently the time during which it is in prime condition is brief, so that harvesting of the fruit must be at short intervals and the handling from the field to the factory be conducted with speed.

The fruit is easily broken from the stalk by a quick lateral and downward thrust and is deposited in a heavy canvas bag which is suspended from the picker's shoulder. When the bag is full, it is carried to the end of the row or to the truck road where the contents are turned upon the ground. Here the crown is broken off and the fruit sorted according to size and filled into lug boxes or crates to be hauled to the nearest railway station or factory. The lug boxes are really crates especially designed for handling this fruit and when filled hold about 60 pounds.

The truck roads are made at convenient distances in the field so that the pickers are not compelled to carry heavy loads and the railways are located so that few hauls by truck exceed two miles. The outstanding exception to this is on the Island of Lanai where trucks are utilized to haul all the fruit to the harbor to be transferred to barges and towed to Honolulu. The trucks for the Lanai transportation have been especially designed for the purpose, as also the trailers used, being equipped with air brakes as the heavy loads are all brought down long grade. The same kind of equipment is now being used on other islands. The freight cars have also been designed for handling the fruit as it is the major item of their business. The cars, whether open or closed, carry about ten tons. A load consists of sixty-eight stacks of crates arranged five crates high. They are set four in width and seventeen in length, the loading in and out being done with two wheel grip trucks. The trains are made up twice daily during the greater part of the season and also during the night when at the height of activity in order that the fruit be canned the same day that it is picked, or on the succeeding day. At the factory, the fruit is unloaded and wheeled directly to the
trimming machine, or stacks are arranged in rows on the receiving platform. It is said that the platform at one factory will hold 100 carloads, or 1,000 tons of fruit, at one time.

Some fruit matures every month in the year but the real harvest occurs between June 1 and September 20, the peak being reached near the end of July or the early part of August. A moderate crop is gathered in from December to March. During the other months the factories operate only occasionally.

Canning

The French were the first to can pineapple, the work being done in the colonies for importation to the mother country. It is not clear just when this was started but evidently before the work was undertaken in Baltimore. They packed the whole fruit in various ways: whole, cut in transverse slices, in pieces cut lengthwise, and in different shapes, and also prepared a grated pulp. The packing was done primarily to provide stock for glace fruits. The work was nearly all done by hand though some devices were made expressly for the purpose. The cook which they used was 2 hours at boiling for the whole fruit, and 18 minutes boiling for liter cans filled with slices or cut pieces. The sirup used was 18 per cent sugar for the pieces and 28 per cent for the slices.

Baltimore was the port at which most pineapples were brought into this country, and being a center for fruit and vegetable canning, it was but natural that any surplus fruit that arrived should be packed. Some packing is reported to have been done in the 70s, but not enough to attract attention until 1885. No special devices for paring, sizing, coring, or slicing the fruit were developed prior to 1892 so that without suitable equipment the operations were limited. All the present automatic devices for working on a large scale have been developed in the Hawaiian Islands since 1913.

The steps in canning are essentially the same as for other fruits but modified or adapted to this particular product. The preparatory machinery is all special and the cooking units are larger than are used in other branches of the industry. These will be treated in detail when discussing the successive steps. The knife was the only instrument used during the experimental period and until 1903 on the Islands. The few machines brought over at that time, while power driven, were hand operated, did imperfect work, and lacked capacity. The best sizing and coring machine had a capacity of from three to five fruit per minute after the peel had been taken off by hand. Four persons were required to handle this number of fruit per minute and even that rate could not be sustained. The local conditions with increasing crops and limited labor supply made a new type of equipment a necessity. It has been met by the development of automatic machines which do complicated operations in sequence, with a degree of accuracy and cleanliness not attainable in hand work; the human element enters only when a matter of judgment is a necessity as in selecting the pieces for the different grades. The speed per person, as measured at the sizing machine, is a hundred times faster than in the initial period.
Grading for Size

The first step in canning is that of grading the fruit to size and it is in reality done in the field by the persons who put the fruit in the lug boxes. The differences between the sizes is such that the work can be done by the eye for the majority of the fruits, only those on the border line being confusing. The No. 1 or large size will not pass through a ring 5 inches in diameter; the No. 2 or medium size passes through a 5-inch ring but not through a 3½-inch ring; while the No. 3 or small size passes through the latter and when trimmed is 2½ inches in diameter. By grading the fruit when filling the lug boxes, it permits diverting the fruit directly to the machines cutting the corresponding sizes without further sorting, though the person who feeds the sizing machine makes a further check by casting out any which may be misplaced.

Trimming

The second operation consists in feeding the fruit into machines which first cut out a cylindrical section of definite size, then cut off the top, bottom and finally remove the core in a series of automatic operations. This is known as the Ginaca machine and occupies the same relation to the packing of pineapple as does the pea viner, the corn cutter, or the “iron chink” to the lines in which they are the most important labor saving devices. It is one of the ten outstanding inventions in the canning industry. Henry Ginaca, the inventor, was not familiar with canning or canning machinery but a designing engineer in Honolulu who was employed by the Hawaiian
Pineapple Company, Ltd., to produce something which would be an improvement over the slow and inefficient devices then in use. The present type of machine was perfected, except in some minor details, in 1914 after he had made two previous attempts.

The sizing machine consists of four parts, a power feeder with a centering mechanism to place the fruit in alignment with the cutting knife, a rotary knife for cutting the cylinder of fruit, a turret for holding the cut cylinder while the top and bottom were cut off, and a core remover.

The pineapple is laid on the feeder which consists of a V-shaped guide in the bottom of which is a sprocket chain, the links at intervals being provided with a push lug or dog. These lugs push the fruit forward into a frame within which are a number of fingers actuated by springs which automatically adjust themselves to fruit of different size and to any irregularities in shape and thus center it in alignment with a cylindrical rotating knife. The push lug on the chain forces the fruit through the centering device and against the cutter and also the shell splitting knives on the outside. The effect is to cut out a cylindrical portion around the long axis of the fruit and to remove the peel in two equal parts. The cylindrical cut of pineapple is forced through the tubular cutter by the succeeding fruit and drops into one of the six pockets in a turret. These pockets are slightly larger than the cut section and hold it in an upright position during the succeeding steps in the treatment. The turret is rotated by an interrupted movement and at the first stage a knife cuts off the top and removes it to one side; at the next stop another knife cuts off the bottom and removes that; at the third pause a hollow plunger removes the core; and at the fourth or final stage the cylinder drops out upon a belt which carries it to the hand trimming table.

The size of the cylindrical portion is made to correspond to the can: No. 1 fruit is sized to fit a No. 2½ can, or made 3¾ inches in diameter, and a 1-inch core is removed; No. 2 fruit is sized for the No. 2 can and is made 3⅛ inches in diameter with a ¾-inch core removed; while No. 3 fruit is sized for the Honolulu tall can and made 2¾ inches in diameter, and the core removed is ¾ inch in diameter.

These machines were originally designed to operate at a speed of 38 fruit per minute, but improvement in details permits a capacity of 80 or more per minute. This is for the No. 1 size, the smaller sizes have a higher speed. As the large fruit weighs on an average of five pounds each, this is the equivalent of 12 tons per hour at the highest speed, assuming a possible 100 per cent efficiency in feeding.

The shell, or peel, which is removed in the formation of the cylinder, is diverted to the feeding device of an eradicator which is now built as an integral part of the Ginaca machine. Here the fleshy portion of the inside of the shell is removed, a part of which is used in crushed pineapple and the remainder for juice. The eradicator was first a separate machine and that type is still in use in some factories.

The sizing machine represents the climax of development and combination of ideas of several persons rather than a wholly new conception by one person. Basically it retains the principles of the first one, the cylindrical cutter and corer invented by George W. Zastrow in 1893, but the added features give it automatic action and large capacity. It is a marvel in a way and
has served as the inspiration for other steps and devices to better utilize the entire fruit and to secure greater efficiency in other operations. The several steps in the development of the devices are shown in Appendix A.

The cylinder of fruit as it leaves the machine represents only about 42 or 43 per cent of the fruit as delivered to the factory; the shell represents about 28 per cent; top, bottom, and core, each about 5 per cent, all of which must be accounted for in the subsequent steps or as waste. At one period, practically 50 per cent was waste.

Hand Trimming

Some hand trimming is necessary to remove any peel left by the machines due to irregularities in the shape of the fruit, to the selection of an occasional one of the wrong size, and to having a taper or cone at either end. A table has been especially designed to facilitate this work. The cylinders of fruit from the Ginaca machine are carried over the top on a slow moving belt which is divided into two parts by a partition board suspended from above. The fruit which needs trimming is taken off and the bits of skin removed by means of a sharp knife, the work being done on a shelf at a slightly lower level than the belt. The trimmed fruit is returned to the half of the belt intended for that purpose, the bits which have been cut off fall through a chute below to be carried to the juice press. The table is narrow so that workers sit or stand on either side and can reach the width of the belt without effort. The work done at this point is closely supervised as the skill exercised has direct bearing on the percentage of perfect slices, since the imperfect must go into the lower grades. Carelessness and deep cutting cause losses which can be traced at once to this source. One method of checking the individual trimmers is to weigh the refuse at intervals. From 12 to 18 women are required on each line, the number depending upon the character of the fruit that is being handled. Rubber gloves are worn here as in all operations involving cut fruit, as the pineapple contains an active en-
zyme, bromelin, which will digest the unprotected skin on the fingers during some hours of work.

The fruit is passed through spray washers to remove any adherent bits left by the machines or trimmers.

**Slicing**

After washing, the fruit is delivered to the slicing machine, another device developed for this particular product. Several type of machines have been patented, but only two are in general use, one in which the fruit is advanced against a set of knives by the reciprocating movement of a semicylindrical holder on the end of an arm, and the other in which the fruit is carried in pockets on the periphery of a drum and pressed against the knives during one stage in the rotation. In both, the fruit drops into pockets having a slightly larger diameter than the cut section and these hold the fruit firmly and evenly while the knives are passing through, thus insuring a clean cut surface and edge, without breaking or tearing. The cutters consist of multiple blades set at the proper angle to give the effect of a drawing movement, which is better than a direct thrust. The pockets are slit at the proper intervals for the knife blades. The usual thickness is one-half inch, which gives eight pieces for a No. 2½ can, though occasionally slices are made to provide for ten or twelve pieces to the can. The thinner slices result in a larger number of imperfect ones. A slicer has a capacity equal to or somewhat greater than the trimmer. By slicing the perfect cylinders on one machine and the trimmed cylinders on another, as is done in most plants, the work of selecting perfect slices when filling the cans is simplified.

The variation in mechanical details of the various slicers is shown in Appendix B.

**Filling the Cans**

The sliced pieces fall upon a belt and are carried to the filling tables, but instead of being diverted into bins as with most fruits, the women pick the pieces directly from the belt and fill into cans. The women at the head of the table take only perfectly cut fruit for the highest or Fancy grade; the next group of women take the slices which are whole but not perfect for the second or Standard grade, and the third group take partially broken slices for the third grade or Broken slices, leaving the remainder to pass to the crusher for Crushed pineapple, or, all not used for Fancy and Standard grades may be crushed. The tendency is to simplify packing by working all the fruit into three grades: Fancy, Standard, and Shredded. In some plants the matter of color enters into the grading, a very light color being sufficient to reduce a Fancy to a Standard grade.

As an aid in picking up the slices, the belt is made with longitudinal ridges about three-sixteenths of an inch high and an inch and a half apart. These keep the pieces free instead of sticking to the belt. It is said that this seemingly slight detail has increased the efficiency on the filling tables fully twenty per cent. A good packer will fill ten No. 2½ cans per minute, though the average is below this number. It requires from 12 to 14 persons to fill the cans on one line. In no other branch of the canning industry is the work done more expeditiously, with less exposure to the air after cutting or with fewer movements. The two rubber belts carrying the fruit from the trimmer to the slicer, and from the slicer to the filling table are kept constantly
cleaned. Another detail at this point is the washing of cans immediately before filling, a sanitary precaution of far more significance than the esthetic elimination of an imperfectly trimmed piece, though, unlike the latter, the difference cannot be seen upon opening the can. This practice is not universal, but on the increase.

The succeeding steps in the handling of the fruit are conducted in a manner similar to those employed on the West Coast. The cans are set in trays holding one dozen each, stacked on trucks and wheeled to the siruper. This one step seems to be inconsistent with the high standard set in the other departments and is as far behind a continuous conveyor system as would be carrying the sliced pieces in buckets from the slicing machine to the filling table.

In addition to whole slices, the fruit may be cut into other forms as the slice may be divided into sectors for use in fruit salad or other fruit mixture. The slices may be diced, the imperfect pieces being separated and diverted into shredded stock while the cubes are used in fruit supreme and in confectionery. A late addition to the list is full lengths cuts. The pineapple is cut to the cylindrical stage, then cut to the length of the can. The cored cylinder is then placed in a can and a machine thrusts a cutter with multiple blades through the fruit dividing it lengthwise, the number of pieces being determined by the number of blades.
Siruping

The siruping is done by machines, of which there are three or four different kinds, but the most popular is a special siruper developed for handling this product and known as the Pittaluga siruper. It is simple in construction, rapid in operation, and efficient.

The sirup used on the Fancy grade is made to test from 48 to 52 degrees Brix or Balling; on the Standard grade, from 30 to 35 degrees; and on Broken or Crushed fruit from 20 to 25 degrees, depending upon the sugar content and acidity of the fruit. With the large increase in the use of Crushed pineapple, about one-third of this pack is being put up in sirup corresponding to the Standard grade. Tests are made at frequent intervals to determine the degree of sirup needed, as a difference of a very few degrees amounts to thousands of pounds of sugar daily in the larger plants. The

object is to have the sirup in the finished product test between 24 and 25 degrees for the Fancy; 20 to 21 degrees for the Standard, and 17 to 18 degrees for the Broken or Crushed, or corresponding to the Second or Standard grade if that sirup be used. The sirup is applied hot in order to reduce the time of exhausting.

Exhausting

Exhausting in the case of the pineapple has a double function, to afford the usual aid in sterilization and safe packing, and to heighten and obtain greater uniformity in color. The time generally given for exhausting well-ripened fruit is from 5 to 6 minutes and may be as much as 10 to 12 minutes for that which is somewhat immature. The less mature the fruit, the more gases are distributed in the tissues, thus giving a white firm appearance, and it also follows that the firmer the tissue, the more difficult the release of the gases. It is necessary to bring the temperature to about 170° F. and hold it for a short time to cause expansion and release of the
so that the tissues will collapse or the spaces fill with liquid and thus give a more translucent appearance and the accompanying effect of tenderness. A light exhaust gives an uneven color, a part of the gas being left in the tissues or escapes into the headspace during the cooking.

Mechanical exhaustion has also been used to accomplish the same ends. The first machines subjected the individual cans to a vacuum to withdraw the gases and then admitted the sirup before breaking the vacuum so that the sirup would subsequently be driven into any interstices by the atmospheric pressure. A short heat exhaust followed to insure a proper vacuum in the can. The method had only a limited use, though it suggested that something might be better.

The next step that followed was to vacuumize the can and its product and make the closure while in the sealing chamber, applying the principle of evacuating the gases while the pieces are submerged in liquid and then sealing the can in vacuo as perfected for fish packing. This permitted drawing a higher vacuum than could be obtained under the former method and thus a better effect, but the time was too short to get the full effect. Since the product is cold, or practically so, allowance needs to be made for additional time in the cooker to compensate for not heating in the exhaust box, or to pass the cans through a preheater.

A new method designed to secure the desired appearance is to introduce the cans of fruit into a pressure chamber and subject them to air or steam pressure for about ten seconds. On fully ripe fruit the pressure is from 25 to 30 pounds per square inch, and for that which is hard the pressure may be increased to 70 to 75 pounds. The external pressure displaces the gases from the tissues by a reversal of the former process and is far more efficient. After the cans come out of the machine they are filled with hot sirup and given a short exhaust.
The patents covering this phase of the canning are found under Appendix C.

**Cooking**

The cooking is done almost exclusively in continuous agitating cookers to insure prompt and even distribution of heat to the contents in the shortest possible time. This was the first line of fruit packing to adopt the principle of agitation. A small machine of only 400 cans capacity was installed in the factory of the Pearl City Packing Company in 1913 and demonstrated unmistakably an advantage over the usual open bath. It was followed immediately by cookers of larger capacity and all sorts of improvised devices to attain the same end, with the result of the present large standardized units holding 1,680 cans operating at the rate of 120 to 125 cans per minute.

The coolers which accompany the cookers are also of a special design to care for the large volume. In this case they are of a vertical type, the cans entering at the bottom and discharged from the top. The cold water strikes the outgoing cans and flows over them to the hottest and thus reduces the temperature gradually without causing undue strains at any instant. The amount of cooling is made dependent upon the volume of water used rather than the length of time in the cooler.

The time given in the open type of agitating cooker is from 12 to 14 minutes.

A pressure type of cooker was introduced in 1924, the first to be used on a fruit product. These operate at 218° to 220° F. ordinarily, but sometimes as high as 240°, thereby reducing the cooking time to 8½ to 9 minutes, though a secondary object is to obtain the deepening of color. A score of these machines are in operation evidencing a popular demand.

The time given in these large cookers, whether of the open or pressure type, is kept nearly constant, and such variations as may seem desirable are made by varying the time in the exhaust box or the degree of cooling. In the majority of cases cooling is conducted at once upon leaving the cooker, the temperature being reduced to about 125° F., or to a point which insures the arrest of cooking but warm enough to cause complete evaporation from the surface of the can and thus prevent rust.

Although Captain Kidwell and those associated with him in the early attempts to pack pineapple had no experience in canning, they worked out a cook at 14 to 18 minutes at boiling to be sufficient for No. 2½ cans and allowed the cans to cool in the air. In an article in *The Pacific Commercial Advertiser*, Feb. 9, 1921, it is stated that the first experiments consisted in cooking lots 10, 20, and 30 minutes, and upon opening, the opinion was that the 10 minutes cooked product was the best, but a compromise was agreed upon to use a 14 minute period. As late as 1904, Captain Kidwell is quoted in the *Experiment Station Record*, by abstract, as follows: “In the canning of pineapples especial attention is called to the necessity of not boiling the fruits more than 14 minutes. Any excess of boiling over this period greatly injures the quality.” This was a short cook compared with that used in Baltimore, but in close agreement with that used by the French. At practically the same time that Captain Kidwell was emphasizing the advantages of the short cooking period, the opposite extreme was being followed in
Jamaica, a heating period of 4 hours at from 150° to 155° F. (Journal of Jamaica Agricultural Society, 1905.)

The usual cook given in Hawaii by the majority of packers prior to the use of the agitating cooker was 30 to 35 minutes in an open bath. This is the cook most used in the Orient at present, where they also cut medium and small pineapples in the form of a spiral after the core is removed. This makes only one or two pieces in a can.

Crushed Pineapple

In the foregoing, consideration has been given to that portion of the fruit which is removed as a cylindrical section for making slices which, because of its size and fine appearance, has the greatest commercial value when canned. The richest and most delicately flavored portion, however, is next to and attached to the skin, the amount naturally varying from a thin to a fairly thick layer, depending upon the diameter of the fruit. It is, therefore, highly desirable that as much as possible of this material be saved both because of its quality and for economic reasons.

In the early stage of pineapple canning, about 1900, when the fruit was peeled before sizing, the portion cut off was run through a grating machine which consisted of two series of fine-toothed saws mounted upon shafts running toward and close to each other but at different speeds, with the result that it produced a finely comminuted product, designated “grated pineapple.” Later, when the volume of pineapple increased, to expedite packing the fruit was sized without previous peeling, and the pulp left adherent to the shell as there were no means for removing it. It became waste and the amount increased until it became a serious nuisance both economically and from a sanitary point. As a result, there was developed an eradicator or device to trim the flesh from the inside of the tough, horny portion of the shell. The first machine for this purpose was invented in 1912 and consisted of a drum on the surface of which were a number of short, sharp pegs to catch into the hard, outer peel and drag the half shell under a roller which flattened it and then drew it under a revolving knife like that used in a wood-planing machine which cut the flesh into small pieces. The machine was not perfect and was soon followed by another in which an adjustable belt with studs took the place of the fixed drum, and a shaving knife the place of the rotary planer, and these two ideas have been incorporated in the present efficient apparatus known as the eradicator. The details of the steps are given in Appendix B.

The removal of the pulp from the inside of the shell, while not complete, represents a distinct saving of nearly 8 per cent. The larger pieces and those devoid of all horny tissue are sorted and run through an Enterprise style of food grinder or cutter and the product then termed crushed pineapple. This type of preparation has practically displaced the grated in Hawaii. The bits have the appearance of being torn but not so finely minced as in the grated. The consumer has taken kindly to the product, and instead of being received with suspicion or with unfavorable prejudice as made from “trimmings” as the case is with some fruits, it is preferred for many purposes. The demand is so large that the quantity is augmented by the addition of the imperfect top and bottom cuts, broken pieces, and whole small fruit. Nearly one-third of the total pack is now preserved in this form.
WHAT BECOMES OF FROM A DOLE PINEAPPLE HAWAII

DOLE JUICE
Pure, natural juice without added sugar

DOLE SLICED
12 5-inch spears, the fruit cut lengthwise

DOLE ROYAL SPEARS

DOLE CRUSHED
From broken, irregular pieces and from fruit adhering to shell

DOLE GEMS
Large, luscious smooth-texture spoon-cuts of golden pineapple

DOLE TIDBITS
Whole slices cut into small uniform tidbits as indicated

THE ABOVE DIAGRAM SHOWS GRAPHICALLY THE PARTS OF THE PINEAPPLE WHICH ARE USED IN THE VARIOUS PREPARATIONS. INDEBTEDNESS IS ACKNOWLEDGED FOR ITS USE.
The crushed fruit is weighed in batches and placed in jacketed kettles with sugar added in proper proportion to make its own sirup and to cut out 24 degrees for Fancy and from 20 to 21 degrees for Standard grades. The sirup may be made of concentrated neutralized fruit juice, or at least in part. The time of cooking the batch is from 10 to 11 minutes, long enough to thoroughly heat the material, drive out air and gas, and to incorporate the sugar. The batch is drawn directly into the filling machine and the cans filled hot. No exhausting is necessary and only a very short cook as a safeguard against contamination from the cans. Some canners do not cook but depend upon the heat from the mass to sterilize the cans.

Thus far the kettle batch method has been followed but there seems to be no good reason why the treatment could not be made continuous, possibly after the manner of cream style corn. The corn and brine are measured by machine, adjusted to the proper proportions, mixed and heated. Crushed pineapple appears to offer a similar problem.

A large percentage of this style of pack is put up in No. 10 cans for large users, as ice cream manufacturers, confectioners, and bakers.

**Regulatory**

A Service and Regulatory Announcement, No. 244, applies to this product and is as follows:

It has been the practice of some manufacturers to make use of the cores and trimmings of pineapples by grating to a finely divided condition and cooking them with water or pineapple juice, with or without the addition of sugar and the solid flesh of the pineapple, canning this product and selling it under names which are not properly descriptive of the product, and in some cases are misleading to the purchaser. In case trimmings are used, there are usually present portions of the “eyes” and the horny skin leading inward to the “eye.”

Cores and trimmings of such character are inferior portions of the pineapple. Regulation 26 of the Rules and Regulations for the Enforcement of the Food and Drugs Act states that products made from “refuse materials, fragments or trimmings” should be labeled in such a way as to indicate the nature of the material used. It is the opinion of the bureau that the product described above cannot properly be labeled “Canned Pineapple,” “Grated Pineapple,” “Pie Grated Pineapple” or with similar terms, unless the label bear, in addition, further descriptive matter clearly indicating the character of the materials used. The above terms, without modification, are held to apply to products prepared wholly from the flesh of the sound, mature pineapple, excluding the core.

**Label Weights**

The following weights are recommended for declaration upon the labels: 8Z Short, 8 ozs.; 8Z Tall, 8½ ozs.; No. 1 Flat or No. 1 Buffet, 9 ozs.; No. 1 Tall, 14 ozs.; No. 1¼, 13½ ozs.; No. 2, 1 lb. 4 ozs.; No. 2½ (in juice), 1 lb. 13 ozs.; No. 2½ (fountain crushed), 2 lbs. 3 ozs.; No. 10, 6 lbs. 12 ozs.; No. 10 (in juice), 6 lbs. 8 ozs.; No. 10 (fountain crushed), 7 lbs. 12 ozs.

**Pineapple Juice**

In order to use the large surplus of fruit and the abundance of trimming stock resulting from canning slices, attempts were made at expressing the juice and canning or bottling in order to create a demand as a soft drink and for use in the home. The efforts were not successful as the method then in use did not insure a strictly stable high grade product and the cost of distribution was too great. Attempts were also made to concentrate the juice with sugar added to make a fruit flavor for soft or carbonated drinks.
but this, likewise, met with little encouragement in competition with cheap synthetic products.

The more recent knowledge of vitamins and their value in affecting nutrition and protecting health and their presence in the juice, plus high nutritive value, has changed all this. During the past four years millions of cases of this product have been consumed in competition with tomato and citrus juices.

Pineapple juice for beverage purposes has to be produced as a primary product to be a success and not as a by-product of canning. The fruit needs to be matured on the stalk until it reaches the soft ripe stage to develop full flavor and bouquet. It is prepared as for canning, grated, and pressed under only moderate pressure so as not to release that which is more or less astringent. Eradicator pulp from large fruit, so that there is a thick layer on the shell, is next best as the portion next to the shell is always more advanced than that which is more deeply seated. The shredding and pressing should be done as speedily as possible, and preferably in an atmosphere saturated with steam to insure the minimum of change. Filtration is simply to remove the coarser particles. The juice is heated to 170° F. in jacketed kettles, preferably of stainless steel, filled in the cans at once and held for twenty minutes. One modification is to fill the cans at once with the cold juice and seal in vacuo so that the heating be done in the sealed can and thus avoid driving off esters.

Plain cans only are used. The declaration of contents recommended is as follows: 8Z Short, 7 fl. ozs.; 8Z Tall, 7½ fl. ozs.; No. 1 Flat or No. 1 Buffet, 8 fl. ozs.; No. 1 Tall Special, 12 fl. ozs.; No. 2, 1 pt. 2 ozs.; No. 2½, 1 pt. 10 ozs.; and No. 10, 2 qts. 1 pt. 15 ozs.

Composition of the Pineapple

When the amount of work that has been done upon the pineapple is considered, one is struck with the lack of data concerning its composition. Several years ago the Bureau of Chemistry made a number of examinations of fresh fruit and Wiley* summarized these as follows:

Composition of 22 samples of fresh pineapples from Florida:

<table>
<thead>
<tr>
<th>Per Cent</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids</td>
<td>13.85</td>
</tr>
<tr>
<td>Total sugar</td>
<td>11.68</td>
</tr>
<tr>
<td>Protein</td>
<td>.4</td>
</tr>
<tr>
<td>Ash</td>
<td>.42</td>
</tr>
<tr>
<td>Acidity</td>
<td>.52</td>
</tr>
</tbody>
</table>

Circular No. 50 of the Department of Agriculture, the “Proximate Composition of Fresh Fruits,” supplies the following:

<table>
<thead>
<tr>
<th>Per Cent</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste, crown, core, parings</td>
<td>39.</td>
</tr>
<tr>
<td>Water</td>
<td>85.3</td>
</tr>
<tr>
<td>Protein</td>
<td>.4</td>
</tr>
<tr>
<td>Fat</td>
<td>.2</td>
</tr>
<tr>
<td>Ash</td>
<td>.42</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>13.7</td>
</tr>
<tr>
<td>Fiber</td>
<td>.4</td>
</tr>
<tr>
<td>Sugar</td>
<td>11.9</td>
</tr>
<tr>
<td>Acid, citric</td>
<td>.72</td>
</tr>
<tr>
<td>Calories, per 100 grams</td>
<td>58.2</td>
</tr>
<tr>
<td>Calories, per pound</td>
<td>265.</td>
</tr>
</tbody>
</table>

The important element, as measured in terms of food value, is the sugar, and this varies with the degree of ripeness. The average sugar content of fully ripened fruit is about 12 per cent which varies little in different places or with the variety. A maximum sugar content of 15.3 per cent has been recorded. With green fruit the sugar may run as low as 3.5 per cent but at this stage the fruit would not be usable. Other disadvantages in using green fruit are such that there is not the same incentive to harvest when in that stage as there is in stripping a tree. The esters which are valuable components in imparting flavor and odor, are like the sugar, not developed to the maximum until the fruit is ready to turn to the soft ripe stage.

Canned pineapple shows a higher food value than does the fresh, due to the added sugar, and this varies with the different grades, thus making an apparent difference which is not present in the fruit. Bulletin No. 5, "The food value of Hawaiian canned Pineapple," from the University of Hawaii (1926), gives the following analysis of the "Fancy" grade of pineapple:

<table>
<thead>
<tr>
<th>Per Cent</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>76.01</td>
</tr>
<tr>
<td>Total sugars</td>
<td>22.30</td>
</tr>
<tr>
<td>Sucrose</td>
<td>9.99</td>
</tr>
<tr>
<td>Reducing sugars</td>
<td>12.31</td>
</tr>
<tr>
<td>Protein</td>
<td>0.44</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>0.30</td>
</tr>
<tr>
<td>Mineral matter (ash)</td>
<td>0.33</td>
</tr>
<tr>
<td>Fruit acids, as citric acid</td>
<td>0.59</td>
</tr>
</tbody>
</table>

The conclusion which naturally follows is that, upon the basis of chemical composition, the pineapple has a fair food value, about the same as the peach, strawberry, or orange, and is not dependent upon its agreeable flavor to merit a place upon the menu though that may well be the determining factor in its selection at times.

Since the complete story of the food value may not be told by the usual chemical analysis, a more exhaustive research into that phase was sponsored by the industry as a whole. The studies included a determination of the vitamins present and the amounts by comparison with other fruits; the presence of unusual minerals as iron, copper, and manganese, and their significance; and the alkalizing effect of canned pineapple.*

These studies show that pineapple ranks in the same class with the orange and the tomato with respect to the three vitamins, A, B, and C. As the orange and tomato and their juices are recommended particularly for growing children, those below par in nutrition, or recovering from illness, and to other persons for keeping up body resistance to disease, it follows that the canned pineapple may be used for the same purpose and to many persons might prove more agreeable.

The presence of iron, copper, and magnesium in an assimilable form is much higher than in either the orange or tomato and in better balanced proportions than in these or other fruits. The body uses very small quantities of these elements but they are extremely important. The point of most significance in this case is that the compounds exist in a form to be utilized.

The pineapple is also classed among the foods which upon being used by the body leave an alkaline residue. The study confirmed this observation and the conclusion drawn that “Through its antiketogenic and alkalinizing effects, the canned pineapple helps to maintain the normal alkalinity of the blood.”

The pineapple has one principle not common to fruits and that is the enzyme or digestive ferment, bromelin. This ferment acts similarly to pepsin upon proteid matter to cause its digestion, an effect easily seen upon the unprotected hands of anyone working with the cut fruit for a protracted time. It is so strong that it is necessary to wear rubber gloves in factory operations. The quantity of ferment is not large but in the fresh fruit is sufficient to aid in many cases of poor digestion and in the comfortable disposal of a large meal. Slow sipping of the juice and holding it in the mouth will dissolve mucus which led at one time to its use in the treatment of sore throat. It was used in the treatment of diphtheria before antitoxin was available. The enzyme is said to be destroyed above 140° F. and therefore lost in the canned product. The recent studies credit it with stimulating digestion, the conclusion being, “Although the juice of the fresh fruit contains an active protein-splitting enzyme, bromelin, in its influence upon the protease of gastric contents, the fresh juice apparently exerts no greater effect than the canned juice which does not contain an active protease.”

The earliest writers ascribed medicinal virtues to the fruit and also to the plant which are not at all surprising as it was in the period when the herbalists were active and enjoyed a vogue. Medicinal or the opposite qualities were considered in connection with nearly all plants and discussed as much as calories were a few years ago or vitamins are at present. Most of the medicinal effects have been noted in the early history of the fruit and it is needless to state that in this case, as in many others, scientific investigations do not sustain all the assertions made by the herbalists and that the fruit must be considered from the standpoint of a pleasing food and not as a therapeutic agent.

Culinary Use

The pineapple won its place in the cuisine as supreme for dessert and that has ever been its chief use, either alone or in combination with other fruits. It had a very popular use in ices.

An early and classical work upon ices was published by M. Emy in 1768, under the title “L’Art de bien faire les Glaces d’Office.” It contains the following: “The rarity of this fruit and its good taste render it valuable. The pineapple is better partaken in ice than eaten in its natural state: sugar, lemon, and pineapple are an agreeable mixture; these three things well proportioned make perfect ices.

“It is necessary to take the pineapple to make ices as one can get them, rarely has one a choice; if one can, he should choose the ripe, that you recognize by thrusting the finger into them; if they yield, they are ripe, as when they have much perfume as already said; often they are ripe through fermentation, but are not so good as when they ripen on the stalk.

“A pineapple of ordinary size makes fifteen to eighteen cups of ice: grate the pineapple on a well heated grater, an ice sieve below, and an earthen dish below the sieve. The pineapple being grated, aid it to pass with
a spoon; what cannot go through should be crushed with some powdered sugar and continue pressing through until only the stringy parts remain; throw three or four spoons of water on the shreds to draw out all the savor. According to the ripeness of the fruit, you use the sugar; if ripe, put in the sugar at the thread, cold. If not well ripened, put in the sugar at the thread, hot: either condition, the sugar must be at the thread; add to the composition the juice of one or two lemons; if the fruit is well ripened, it will bring out the taste, and render the freezing excellent; when you think the composition right, neither too thick nor too light, sufficiently sugared, repass it through the sieve to mix the whole well and freeze it.

"Some stewards boil the pineapple with the sugar, but I am sure that the heat alters the taste of the pineapple to the point of being no longer recognizable; if one wishes to follow this usage, he is free to do it, but the first is the best, following my principle."

By-products From Waste

After the slices and crushed product have been placed in cans, there still remains more than 50 per cent of that brought to the factory to be accounted for, and at one time this was all waste as well as some of that which is now used in the crushed product. The cheapest method of handling was to load it upon barges and tow it out to sea, but wind and tide were frequently capricious and distributed it along the shore or upon the beaches. The quantity was too great to return it to the land and fermentation not only generated noxious odors but drew innumerable flies and other insects. Conservation was, therefore, doubly important, to save that portion which could be utilized profitably and to avoid the cost of disposing of a nuisance. In 1910, T. F. Sedgwick showed that a ton of the waste at that time contained 1,700 pounds of juice and 100 pounds of dried pulp and that the juice might be made to yield 17 pounds of citric acid and 20 gallons of molasses, but no practical methods for making the recovery were developed. During the same year and for some time following, the Hawaiian Pineapple Company, Ltd., pressed the juice from the better waste separated by the eradicator and attempted to market it as a beverage in bottles, but that provided only a small outlet. In 1913, the Hawaiian Station reported work upon the making of vinegar from the juice. The acidity was rather low, about 3.8 per cent, but occasional batches ran as high as 4.8 per cent. Extraneous organisms interfered with the proper fermentation so the prospects along that line were not encouraging. A further obstacle was the high cost of shipment for a low priced product.

Presses were installed at one factory to get rid of the watery portion and the remaining solids were partially dried and used as fuel.

A systematic study of the waste, with the object of conserving all that might be useful, was begun in 1913 by R. A. Gould and C. S. Ash, chemists of San Francisco. Their scheme was comprehensive: to press separately all the pulp which could not be used in crushed fruit, in addition to the shells and other fibrous materials; to treat the juice so as to recover the larger part of the citric acid; to clarify the neutralized juice and to concentrate and use this portion to take the place of part of the cane sugar in making the sirup; to use a diffusion process on the solids, and to recover other sugar for sirup, spirits, or vinegar; and to dry the residue for fuel. At that time, 1,000 pounds of waste yielded approximately 600 pounds of solids
and 400 pounds of juice. The latter yielded approximately the equivalent of 40 pounds of sugar. The steps in the recovery of this sugar in the form of sirup suitable to be used on the fruit are simple—pressing the waste and clarifying and evaporating the juice, the costs being low in each instance. The citric acid is likewise easily recovered with lime in the form of calcium citrate, the quantity being equivalent to about 4 pounds of citric acid in the thousand pounds of waste. The refuse, treated in a diffusion apparatus, yields sugar which may be converted into alcohol and finally into vinegar. The amount of citric acid obtained from the diffusion liquor is greater than from the pressed juice or about 13 pounds in 1,000 pounds of stock. Some of these steps, it is claimed, were already being used in part but not as efficiently or economically as contemplated in their plan.

The California Packing Corporation installed a reduction plant to recover these by-products and others followed certain steps, particularly the utilization of the juice to take the place of some cane sugar. No complete unit is in operation.

The patent covering the recovery of by-products is so distinctive that it may well serve as a model for work along other lines and is reproduced in full except for the claims. It is found in Appendix C.

Pineapple Bran

Pineapple bran is a trade name given to the dried and shredded material obtained from the shells, trimmings, and other parts not used in the packing of sliced and crushed pineapple or in the making of sirup. The solids are dried at a fairly high temperature without burning which gives it the appearance of bran.

This product was developed by the Hawaiian Pineapple Company, Ltd., in 1921 in an indirect manner. A dryer installation was being used to prepare the refuse for burning when, toward the close of the season, it was noticed that the product made when the dryer was not operating at full capacity and at a lower temperature, was of a fairly light color, of a sweetish taste and a pleasing odor, due to not being overheated or burned. A chemical examination by H. E. Savage showed that the waste being delivered to the furnace had the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>10.63</td>
</tr>
<tr>
<td>Protein</td>
<td>3.62</td>
</tr>
<tr>
<td>Fat</td>
<td>1.01</td>
</tr>
<tr>
<td>Sugars</td>
<td>20.66</td>
</tr>
<tr>
<td>Starch</td>
<td>42.15</td>
</tr>
<tr>
<td>Fiber</td>
<td>18.23</td>
</tr>
<tr>
<td>Ash</td>
<td>3.70</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

These figures indicate a high nutritive value which has since been confirmed by feeding tests.

When one considers the number of tons of waste, and the simplicity of the method of recovering the valuable part, it brings a happy solution to one of the perplexing and expensive problems and adds much to the feed supply for the animals on the island. Between 7,000 and 8,000 tons were produced in 1927 and disposed of at some profit.
Sizing, Coring and Slicing Machines

The development of the mechanical devices used in the preparation of pineapple for canning is exceptionally well covered by patents, and a summary of the important features of these as well as of a few non-patented articles is necessary to complete a story of interesting achievements.

Patent No. 482,492, September 13, 1892, issued to George W. Zastrow, Baltimore, Maryland, is for a sizing, coring, and slicing machine. He states "The object is to take rough-pared fruit and run it through a machine which will size, core, split and slice it." The machine resembles a lathe in appearance. The fruit is first divested of its hard skin by means of a knife and the top and bottom cut squarely across. The bottom of the fruit is pressed against what corresponds to the tail-stock of the lathe, and a heavy corkscrew-like holder is forced into the core and this holds the fruit firmly in alignment with the revolving tubular cutting knife. The holding block is moved toward the cutter tube by means of a hand lever, the fruit being cut into the shape of a cylinder the diameter of which is somewhat less than that of the can used in packing. At the same time a smaller tubular knife, mounted centrally within the sizing knife, cut out the core, while a third or lateral knife, on one side of the coring tube, slits the cylindrical section as it is being formed. The coring tube remains stationary. The core is withdrawn with the holding block and released by turning the handscrew backward. The cylindrical section of fruit is released from the inside of the knife by the pressure of the next fruit. It slips into a semi-circular trough of only slightly larger size and is forced backward to be cut into slices by means of a knife mounted on a revolving disk. The blade is curved after the fashion common to bread and meat slicers. The slit in the slice was necessary at that time and until 1909, in order to get the slice into the can, the open top can not being available.

This patent marks the beginning in this field and was for a light powered machine of small capacity. When one attempts to evaluate the different efforts, it stands out as an ambitious attempt, and two features, the rotary sizing cutter and the coring tube, have persisted in nearly all subsequent inventions. A modified but improved form of this machine continues to be manufactured to supply factories of small or moderate capacity. This is covered by subsequent patents, Nos. 735,649, August 4, 1903, and 805,-178, November 21, 1905.

During the same period some unpatented devices became available, the exact date not being ascertained.

The Lewis Pineapple Peeler is a light power-driven machine consisting of a short planer style of knife on a spindle and in front of which is a holder for the fruit. The latter consists of a pin and fork mounted in line so as to impale the fruit at the top and bottom. The holder is then moved against the revolving cutter to remove as much of the outer layer as desired. It does better work than a hand knife but has been supplanted by other methods which make preliminary peeling unnecessary. The principle of the planer knife was later incorporated in an eradicator.

The Lewis Pineapple Coring machine is an accompanying device built as a light power bench machine consisting of a hollow shaft with an ex-
tension made thin and of the proper diameter to cut and remove the core. The peeled pineapple is held in the hand and pressed against the revolving cutter tube.

The Mitchell Pineapple Sizer is also a simple bench machine utilizing the same principle as the corer just described. The cored fruit is slipped on a pin which fits snugly into the core hole. A pair of guide rods holds the fruit in alignment while it is being pressed against the knife by hand.

A Slicing Machine, consisting of a horizontal rotary knife mounted within a frame with fruit holding pockets above, is another development. The knife can be set for any desired thickness of cut, and the feed is made by gravity. The principle is the same as in a kraut cutter. A catalogue as late as 1908 claims: “We can safely state that it will cut more pines than any one house can pack.”

Patent No. 891,555, June 23, 1908, issued to James Lindsay, Haiku, Hawaii, is for a hand operated coring machine. The peeled fruit is centered on a block and a cutting tube the size of the core is forced through the fruit by means of a lever.

Patent No. 930,021, August 3, 1909, issued to L. E. Arnold, Honolulu, Hawaii, is for an improved power slicing machine. The trimmed cylinder of fruit is placed or fed into a semi-circular pocket mounted on the end of an arm. By a thrust motion of the arm the fruit is forced against the spaced parallel knives, the blades being fixed and at such an angle that a drawing or slicing effect is produced while cutting through the fruit.

Patent No. 978,383, December 13, 1909, issued to E. A. Lister, Pearl City, Hawaii, provides for a ring with a number of knives on the inside set so as to slit the shell lengthwise and to a depth to just reach the cylindrical cut. The principle is retained in the machines which have followed but in most cases only two knives are used. This improvement eliminates the necessity for preliminary peeling and marks the second step in the development of the sizing machine.

Patent No. 995,491, June 20, 1911, issued to Nickolas K. Smythe, Hilo, Hawaii, is for a slicing machine. The trimmed and cored cylinder of fruit is placed in a pocket of an arm acting through part of an arc of a circle, the pineapple being brought in contact with straight knives mounted parallel at the desired spacing. The blades are set at such a pitch as to give a shearing cut. The new feature is the mechanism for bringing the fruit against the knives.

Patent No. 1,001,931, August 29, 1911, issued to C. W. Cookson, Wahiawa, Hawaii, is for a machine which contains a new principle, a mechanical centering and holding device in which the fruit is placed to be directed against the sizing knife and coring tube. The centering is effected by means of a split ring, the parts of the ring being actuated by springs so as to make adjustments for fruits of different diameter or for irregular shape. The splitting of the skin is done after the manner indicated in Patent No. 978,383. The machine is hand operated and therefore of small capacity but important as having the germ for the centering mechanism.

Patent No. 1,006,621, October 24, 1911, issued to L. E. Arnold, Honolulu, Hawaii, is for a mechanism somewhat like the first sizing machine but with a tubular slicing knife with a sawtooth construction for the cut-
ting edge. This obviates the necessity for using power. The tube is also provided with a longitudinal blade on the outside to split the shell.

Patent No. 1,039,026, October 1, 1912, issued to H. G. Ginaca, Honolulu, Hawaii, is for a machine in which is combined the principles of the tubular shearing knife of Arnold and the fruit centering principle of Cookson but in a more convenient form for a power machine. This marks the first attempt in combining operations with a view to getting quantity production, though the attempt was not a success.

Patent No. 1,060,247, and No. 1,060,248, April 29, 1913, issued to H. G. Ginaca, is for an improved centering device consisting of spring actuated fingers on the inside of three sides of a frame, the fourth side being open so that the fruit might be brought into position by means of a feeding chain and thus greatly accelerate operation.

Patent No. 1,060,750, May 6, 1913, issued to H. G. Ginaca, is for an improved construction of the sizing knife.

Patent No. 1,075,031, October 7, 1913, issued to H. G. Ginaca, is for further improvements on the centering device.

Patent No. 1,112,130, September 29, 1914, issued to H. G. Ginaca, is for a device to trim the top and bottom, and to core the fruit in a series of automatic operations after it is sized. The apparatus consists of a turret with pockets on the periphery, the pockets being slightly larger than the cylinder of fruit. The turret is actuated by an interrupted movement. The fruit is discharged from the sizing machine into a pocket in the turret; at the first interruption the top is cut off, at the second the bottom, at the third the core is removed, and at the fourth the finished cylinder is discharged upon a belt to be carried to the hand trimming table. This machine, coupled with the feeding and sizing mechanism, represents the complete development of the principle of the automatic high speed machine of the inventor and only minor modifications have been made since.

Patent No. 1,130,819, March 9, 1915, issued to J. Hill, Honolulu, Hawaii, is for a device for feeding cylinders of pineapple into an Arnold slicing machine.

Patents Nos. 1,142,216, and 1,142,217, June 8, 1915, issued to F. W. Wolf, Honolulu, Hawaii, are for a slicing machine. The fruit is fed into pockets on the periphery of a drum. The movement of the drum carries the fruit forward against a set of parallel blades that cut the slices to the desired thickness. The drum is given an interrupted movement and coring may be done at one stage if desired.

Patent No. 1,466,337, August 28, 1923, issued to L. Hirsch, Honolulu, Hawaii, is for a slicing machine. The sized cylinders of fruit are fed into pockets in a turret and the movement of the turret carries the fruit against knives spaced to cut slices of uniform thickness.

Patent No. 1,590,162, June 22, 1926, issued to C. H. Hargreaves, Manly, Queensland, Australia, is for a machine for peeling, sizing, and coring the pineapple. It is of light construction like a huge apple peeler, but not adapted to large factory operations.
Graters, Cutters and Eradicators

Since slices constitute only about 45 per cent of the weight of the fruit brought to the factory, it is a highly economic problem to recover and utilize as much of the remaining edible portion as possible in a form acceptable to the consumer. The matter of recovery of the flesh left on the shell by the sizing machine became acute after the preliminary peeling was found to be too slow and difficult to fit in the general scheme of rapid production of slices. Fortunately mechanical devices have been developed that conserve a large part of what would otherwise become waste and the material so recovered is in a form that fits a special need in some culinary operations as pastries and confections.

The Mitchell grater, to utilize the outer portion of the flesh cut off by the Zastrow sizing machine, was produced about 1900. It consisted of two sets of small saws mounted on shafts running close and towards each other but at different speeds. The tissue was cut very finely and termed grated.

About the same time, or a little later, the trimmings were run through an Enterprise food cutter. The openings in the plates were made extra large and the product became known as crushed pineapple. The simplicity of the machine, combined with its large capacity, made it a favorite with the packers and gave it a monopoly in the field.

Patent No. 862,241, August 6, 1907, issued to E. K. Ellsworth and B. Clark, Wahaiwa, Hawaii, is for an apparatus to cut peeled pineapple into long square strips. The apparatus consists of a tube slightly larger than the trimmed cylinder. The pineapple is fed into the top of the tube and becomes engaged by two sets of revolving cutting disks which are mounted on the outside but the blades enter through slits in the side of the tube. The first set of disks cuts the cylinder in flat strips, and as these pass downward they are engaged by another set of disks set at right angles to the former thus converting the flat strips into squares on cross section. The product has its chief use in confectionery. Probably of even more interest is the fact that it was the first patent pertaining to pineapple originating on the Islands.

Patent No. 1,034,144, July 30, 1912, issued to O. H. Rene, Honolulu, Hawaii, for an eradicator for removing the pulp left inside the shell after cutting out the cylinder. The apparatus consists of a drum upon the surface of which are many sharp pegs, a roller set near the drum to flatten the half shell or strips of pineapple so as to cause the pegs to catch hold of the outer or horny side and drag it under a rotating planer knife to cut off any layer of pulp which may be adherent to the shell. The planer knife is practically the same as that used in the Lewis peeler and at high speed cuts the pulp into fine bits. It marks the first step in the recovery of a valuable waste material.

Patent No. 1,060,249, April 29, 1912, issued to H. G. Ginaca, Honolulu, Hawaii, is for an eradicator in which a belt studded with pegs is used to drag the pieces of pineapple shell over a rotating planer knife. The wide pulleys over which the belt is stretched are mounted so as to have a limited amount of motion and thus accommodate shells of varying thickness.
Patent No. 1,060,250, April 29, 1913, issued to H. G. Ginaca, is for a combination of the sizing machine and eradicator with a view to making the two work automatically and continuously.

Patent No. 1,060,309, June 17, 1913, issued to H. G. Ginaca, is for an improvement upon the eradicator in that an oscillating flat knife takes the place of the planer type, resulting in a marked improvement in the product.

Patent No. 1,065,445, June 24, 1914, issued to R. Lister, Honolulu, Hawaii, is for a simple eradicator utilizing the principle of the grid belt feed and the rotating planer knife but with the added feature of cutting the shell into strips so as to feed more closely and evenly to the hard portion.

Patent No. 1,138,143, May 4, 1915, issued to J. A. Olsen, Honolulu, Hawaii, is for an eradicator similar to No. 1,034,144, but with modification of some of the details.

Patent No. 1,271,868, June 9, 1918, issued to J. Dunn, Honolulu, Hawaii, is for an eradicator using a grid belt for drawing the shell against a knife, but before reaching that point it is slit lengthwise in parallel strips so that each strip is flattened without using as much pressure as with other machines. The cutter consists of a revolving disk instead of a stationary flat knife.

Patent No. 1,350,096, August 17, 1920, issued to G. E. Fisher, Honolulu, Hawaii, is for a flesh eradicator, using the drum principle and a knife with a shaving blade instead of the planer type. The shells are turned back downward to prevent the hard specks from falling into the cut flesh.

Patent No. 1,370,634, March 8, 1921, issued to J. Dowson, Honolulu, Hawaii, is for an eradicator having a drum with pegs but instead of having a flat surface as in other machines, it is made concave so that the shell is more nearly adapted to the contour without using much pressure. A second roller is made convex with the same general curvature as the drum. The shells, flesh side upward, are fed between these revolving parts. The convex roller has the further function of cutting the shells into strips before they are forced against a cutting blade having the same curvature as the drum.

Patent No. 1,444,535, February 6, 1923, issued to E. E. Barter, Honolulu, Hawaii, is for a feeding mechanism for the eradicator. The object is to hold the edge of the shell down and thus prevent the entrance of numerous bits of the horny layer into the cut material.

Patent No. 1,460,559, July 3, 1923, issued to H. F. Opperman, Honolulu, Hawaii, is for a machine to take the shells directly from the sizing machine and feed them automatically into the eradicator.

Patent No. 1,471,336, October 23, 1923, issued to M. O. Johnson and A. H. Lowrie, Honolulu, Hawaii, is for a mechanism to trim the cut ends of the sized pineapple. A rotating shaft is provided with an end piece the size of the core hole and near the base are knives protected by a shallow cup. The cylinder of pineapple is slipped over the end piece and a slight pressure brings it against the knives. The device is intended to be used on the trimming tables to take the place of the hand knife in trimming the ends.
Patent No. 1,556,053, October 6, 1925, issued to R. P. Warren, et al., St. Louis, Missouri, is for a cutter to make cubes of the sliced pineapple and also to provide for separation of the imperfect from the perfect pieces. Two series of parallel blades arranged at right angles to each other cut the fruit into squares when it is pressed against them. Deflectors arranged below the blades divert the imperfect pieces from the perfect cubes. The device is intended for preparing material for confections and like purposes.

Patent No. 1,819,575, August 18, 1931, issued to R. B. Taylor, Kapaa, Hawaii, is for a press to squeeze the pulp from the shells as they come from the sizing machine. One roll has low close corrugations and the other, which comes in direct contact with the pulp, is plain.

Patent No. 2,023,810, December 10, 1935, issued to Albert Homer, Kapaa, Kauai, Territory of Hawaii, is for a method of cutting the flesh on the peel into squares and then removing the same from the shell. The object is to make it more attractive and give it a higher value than the regular shredded product.

APPENDIX C
Treating Fruit and By-products

Patent No. 1,039,350, September 24, 1912, issued to W. Baldwin, Haiku, Hawaii, is for a method of treating fruit and contains the following:

This invention relates to a process for treating pineapples preparatory to canning, and pertains especially to the treatment of that variety of pineapples known as the smooth cayenne pineapples. This variety of pineapples varies greatly in flavor; in acid; in sugar content and in color of pulp. The fruit which shows the lightest colored pulp is higher in acid content and inferior in flavor. It is, therefore, less desirable as compared with fruit that shows a deeper colored pulp, and for the canning industry it is very desirable to effect a uniform color and flavor in the canned fruit. With this object in view, experts have been working and experimenting for years, both in the field and the cannery, and the process described below, when used on the light colored fruit, so improves the flavor and the color of the fruit as to make it compare favorably with the best fruit which has the deeper colored pulp and a lower acid content.

The object of the present invention is to provide a process or method for deepening the color, removing and diluting acidity content, and improving the flavor of smooth cayenne pineapples preparatory to canning in hermetically sealed packages.

In carrying out the process, the rind of the pineapple is removed, after which the fruit is immersed in pineapple juice, either diluted or undiluted, preferably clarified, and subjected to a steam bath at approximately a temperature of 200° F., for a short period, preferably not more than 4 or 5 minutes, or sufficient to remove the undesired acidity content of the pineapple. Then the liquor resulting from this first cook is drained off, taking with it this undesirable acidity content of the original raw fruit. The second step in the process is the covering of the hot fruit with fresh syrup consisting either of sugar and water or a clarified pineapple syrup; the whole being then subjected to a steam bath at a temperature of approximately 200° F. for a period of approximately 3 or 4 minutes, or sufficient to deepen the color to the desired point and yet not destroy the natural pineapple flavor. It is during this second cook that the desired results of changing or deepening the color and improving the flavor are obtained. If it were not for the first step as above, the desired change of color in the second step would not result.

As far as could be learned, no practical use had been made of this process.

Arnold Patent

Patent No. 1,046,716, December 10, 1912, issued to L. E. Arnold, Honolulu, Hawaii, is for a "Process of Coloring Pineapples," in which the preliminary statement is as follows:
The invention has special reference to the treatment of pineapples, in which application the process has been found to be of great commercial importance. Pineapples are canned in large quantities, and the improved process lends itself readily and with marked advantage to the treatment of pineapples that are to be placed on the market in this form. By the present process a pineapple of a light color and not fully ripe may be turned to a yellow or golden color and sweetened in a remarkably short time, after which it will have the appearance and properties of a fully matured luscious pineapple. In this case, already peeled fruit, which does not need to undergo any preliminary treatment, is treated with a suitable sirup which may, for example, consist of refined cane sugar and water, with which the pores or cells of the fruit are filled in the manner to be hereinafter described.

Briefly, the process consists in placing the prepared fruit in the cans, feeding the cans into a machine having a disk or cover with suitable openings and a gasket to make a tight seal on the top of the can, withdrawing the air, then admitting sirup which rushes into the space previously occupied with gas or air, and finally sealing in the usual manner. The container is subjected to a vacuum of about 28 inches of mercury for about 45 seconds, or long enough for the gases to escape from the tissues. The change in color is almost instantaneous after the syrup is admitted, but it can hardly be due to the sugar solution, which in itself is colorless. Of course this solution must enter the cells of the fruit and remain permanently therein, in order to give the fruit the desired sweetness and flavor. It makes no change, however, in the color of fruit which is yellow before treatment.

The claim is as follows: A process for coloring light colored pineapple which comprises sealing the peeled pineapple in a suitable container, evacuating the container to withdraw the air or gases from all the pores or cells of the fruit and admitting to the evacuated container a syrup of refined cane sugar and water which enters all the pores or cells of the pineapple and so affects its properties as to immediately change the color of the pineapple.

The principle involved in this patent had been used previously on other fruits but in this case there is recognition of the need of high vacuum maintained for an appreciable time in order to get the full benefit of the treatment, two points which have been underestimated by some others.

Gould and Ash Patent

Patent No. 1,166,674, January 4, 1916, issued to R. A. Gould and C. S. Ash, San Francisco, California, is for the "Utilization of Waste from Pineapple" and is so distinctive and comprehensive that it is reproduced in full except the introduction and claims.

This invention relates to a method of treating pineapple waste with a view of utilizing and recovering values which have heretofore been a commercial loss; and to a novel fruit syrup resulting from such treatment. In the canning of pineapple it is customary after the fruit comes to the cannery to free it of its top and bottom waste and cut from the fruit by means of proper cutting machines a cylinder of fruit. This cylinder of fruit with its core removed is sliced transversely into slices about one-half inch thick. These slices are put in containers and a syrup made from cane sugar is poured into the container to fill it and preserve the fruit. Several forms of canned and preserved pineapple are made and pineapple juice is also a product of the pineapple canning industry.

Owing to the fact that the size or diameter of the slices of fruit is governed by the size of the can, there is a large amount of waste product in preparing the cylinder of fruit from the pineapple. This waste amounts to about fifty per cent of the weight of the fruit delivered at the cannery. Save for the outside horn-like covering of the fruit, the waste is of the same approximate composition as the cylinder of fruit prepared by the cutting machines. The question of utilizing this enormous amount of waste is of paramount importance.

The object of our process is to recover, from what in the past has been an absolute waste and a source of expense to canners to dispose of, a commercial sugar syrup suitable for canning purposes, and in addition to such syrup, recover in a commercially salable condition such other constituent compounds and substances as may be contained in such previously considered waste product, by a system of pressings, treat-
ments, mechanical transfers and combinations as hereinafter described. By our process this waste is so treated as to produce from it a sugar syrup suitable for canning purposes which is composed of invert sugar (d-fructose and d-glucose) and sucrose. The syrup contains a very small amount of some of the substances, other than sugar, contained in the fruit originally.

Other objects incidental to the process are the recovery of the citric acid contained in the fruit, either in the form of citrate of lime or other insoluble salt of citric acid, or as crystallized citric acid; further the recovery of the natural content of vegetable
albumin in a form adaptable for use in various industries; and the utilization of the cellulose content of the waste.

Briefly and generally the process may be described as follows: The juice is removed from the waste by pressing or by diffusion, or by both pressing and diffusion. In the case of the use of a combination of pressing and diffusion, the waste, consisting of peelings, cores, meats, etc., of the pineapple not available for use in the canning industry, is prepared for pressing for the purpose of extracting all available free running juice. From this point two stages develop up to a definite point of the general process: 1st, the handling of the pressed pulp; 2nd, the handling of the pressed juice.

1. The pressed pulp is conveyed into a diffusion battery of various numbers of cells in which hot water under pressure is introduced in continuous method from cell to cell until the resulting juice indicates that practically all of the sugar content has been removed from the pulp. This resulting juice is pumped to a receiving tank and consolidated with pressed juice, at which point the process becomes identical for the two produced juices. The resulting pulp, from which the sugar and other substances have been removed by the diffusion process, is emptied from the cells, conveyed to presses and the water content squeezed out. The semi-dry pulp can be subsequently utilized, after additional drying, as a fuel, fertilizer, etc., as may be found desirable, at a very low cost.

2. The juices from the presses which deliver the available free running juice are passed through a centrifugal filter or a proper form of filter screen to remove vegetable fiber and coarse suspended matter and are then combined with the juice from the diffusion battery in the receiving tanks, above mentioned. The mixed juices are now heated to the correct temperature for coagulating the albumin, which is then separated by decantation or filtration. After separation of the albumin the juice is conveyed to mixing tanks to be chemically treated for the purpose of neutralizing the acid content of the juice. The neutralized juice is subjected to filtration or decantation to remove the insoluble citric acid salts and other products and then transferred to an evaporator where it is concentrated in vacuum to the desired amount. The concentrated juice is again filtered or decanted to remove any insoluble salts of citric acid that have been thrown down by the concentration together with any other products which have precipitated. The colored concentrated juice is then passed through proper medium to decolorize it and produce the final commercial sugar syrup suitable for canning purposes. And in addition to the above general outline, various and sundry methods of conserving wash waters, off colored syrup, reduced and concentrated juices developed in the process.

The drawing diagrammatically illustrates an apparatus readily comprehended by anyone skilled in the art, suitable for practising the invention.

Our process is novel and useful in the following respects: 1. It produces a commercial sugar syrup suitable for canning purposes from fruit juice, which syrup is composed chiefly of invert sugar (d-fructose and d-glucose) and sucrose. There are at present no sugars or sugar syrups recovered, commercially, from fruits, of which we are aware. No fruits contain only sucrose and few fruits contain only invert sugar (d-fructose and d-glucose) or a mixture of invert sugar (d-fructose and d-glucose) and sucrose. The only sugars of extended commercial use or importance are sucrose (cane sugar, beet sugar, or maple sugar) and dextrose (d-glucose), which is made from starch. The only commercial syrups now obtainable are sucrose syrup, which is made from either cane, beet or maple sugar; glucose syrup, made from starch and consisting of d-glucose, dextrin and allied bodies, which is usually sold under a trade or fancy name; invert sugar syrup, made by the hydrolysis of sucrose, and honey which is a natural product composed mainly of invert sugar, (d-glucose and d-fructose,) but containing some sucrose. There are no commercial sugar syrups produced from fruits. There are commercial fruit syrups which are in the main fruit juices sweetened with sucrose or cane sugar, although there do exist concentrated fruit juice syrups which are the fruit juice concentrated with all of its original constituents more or less intact in the concentrated product. There are no commercial sugar syrups suitable for canning purposes at present produced from fruit. 2. It produces commercial calcium citrate or other insoluble salts of citric acid, or citric acid from fruit juice, other than lemon juice, which latter is the only commercial source of citric acid at the present time. 3. It produces vegetable albumin from fruit juice.

For the accomplishment of the new and novel processes and the production of the new and novel products the method of procedure is, advantageously as follows: The
APPERTIZING

waste as it is produced at the cannery is prepared by suitable comminutors 1, for pressing, and is then run to presses 2 in which all of the available free running juice of the fruit is expressed. The pressed juice is strained through a centrifugal filter or a proper form of screen 3 to remove vegetable fiber and coarse suspended matter and is conveyed to a receiving tank 5. The pressed pulp is conveyed to an apparatus 4, known as a diffusion battery. The diffusion battery is advantageously of the type used in the extraction of sugar from beets. By maintenance of proper temperature and proper water supply the juice which remains in the pressed pulp is washed or diffused out of the pulp leaving it a mass of pulp composed only of cellulose and other substances insoluble in water. The preferred temperature for the diffusion water, as shown by practice, for this operation is 160° F. and the preferred pressure is 20 pounds per square inch. Temperatures and pressures greater than these permit more or less complete extraction and temperatures and pressures less than these also permit more or less complete extraction. The temperature 160° F. and the pressure 20 pounds per square inch are preferred in practice because much lower temperatures do not rapidly exhaust the pulp while much higher temperatures cause the sugar to decompose with the production of caramel and also cause the pulp to channel. Much lower pressures prevent the free flow of water and much higher pressures cause the pulp to mat and thus prevent complete diffusion. The preferred temperature 160° F. and the pressure 20 pounds per square inch are preferred in practice because much lower temperatures do not rapidly exhaust the pulp while much higher temperatures cause the sugar to decompose with the production of caramel and also cause the pulp to channel. Much lower pressures prevent the free flow of water and much higher pressures cause the pulp to mat and thus prevent complete diffusion. The diffused juice is pumped or conveyed to the receiving tank, 5, where it is mixed with the strained pressed free running juice. The diffused pulp is then pressed at 26 to remove water and is then conveyed to a drying apparatus 27, of proper design, in which most of the water is driven off. From this point the dried pulp can be used as a by-product, per se, or be burned for its fuel value, and the ash (mineral matter) produced, can be sold as fertilizing material. The mixed juices from the receiving tank 5 are heated to a temperature of approximately 180° F., by proper apparatus as 6, to coagulate and precipitate the vegetable albumin which is held in solution. This temperature is preferred in practice, because much lower temperatures do not coagulate all of the albumin present and much higher temperatures produce decomposition products from the sugar, as caramel. The precipitated albumin is separated from the juice by decantation or filtration, by means of proper apparatus 7, and the resulting juice is conducted to a mixing tank 8 for neutralization.

In the mixing tank 8 the juice is treated with a neutralizing agent, which will produce an insoluble compound with citric acid, in such quantity as to reduce the acidity of the juice to an amount equal to or less than the acidity of N/20 acid and as to prevent the presence of an amount of alkali greater than the equivalent of N/50 alkali. The point of neutralization preferred in practice is to bring the acid content of the juice to a point approximately equal to that of N/100 acid. The neutralizing agent preferred in practice is lime (CaO) or whiting (CaCO3); other agents available are salts of barium, strontium and various alkaline earths. During the neutralization process the juice is constantly or intermittently stirred, as indicated by the physical condition of the precipitate, by a proper stirring device and when the neutralization is finished the material is run to a storage tank 9. The mixture of neutralized juice and insoluble precipitate is then separated by decantation or filtration by suitable apparatus as 10. The insoluble precipitate is washed and conveyed to the citric acid recovery plant 29, with or without drying in a suitable drying apparatus 28 for working for its citric acid value, or the dried citrate can be sold as crude citrate. The filtered juice, now freed of its acid and containing the original sugar of the fruit, and citric acid salts in solution, is collected in a tank 12, and then conducted to a vacuum evaporator 13, where it is concentrated by proper operation of the concentrating apparatus to any sufficient degree of sugar strength suitable for a syrup suitable for canning purposes. During the concentration of the juice the greater portion of the salts held in solution precipitate out while the sugar is held in solution in the form of syrup. Upon obtaining sufficient degree of concentration the syrup with its precipitate is withdrawn from the evaporator and by suitable filtering or decanting apparatus as at 15, or other means, the insoluble precipitate is removed. The insoluble precipitate is washed and conveyed to the citric acid recovery plant 29 with or without drying in a suitable drying apparatus 28 for working for its citric acid value, or the dried citrate can be sold as crude citrate. The filtered syrup is conducted through a proper heating device 16, by means of which the temperature of the syrup is raised to the proper degree for effecting decolorization. By means of proper operation of the decolorizing system 17, there is produced as a final product a commercial sugar syrup suitable for canning purposes. This proper operation includes the control of the temperature of the syrup
while it is in the decolorizing system. We have found the preferred temperature in practice, at which to keep the syrup to be 160° F., and the preferred decolorizing agent to be animal charcoal or (bone char). Temperatures higher than 160° F. produce caramel by the decomposition of the sugar, which substance is very difficult to remove from the syrup by the decolorizing agent. Temperatures lower than 160° F. decrease the capacity of the decolorizing agent. The final product, a commercial sugar syrup suitable for canning purposes, may contain a small part of the original coloring matter of the juice or none of it; it may contain a trace of the original acid of the fruit or none of it; it may contain a trace of the original mineral matter of the fruit or none of it, and it does contain all of the original sugar of the fruit. This sugar is not, however, in its original chemical composition. The sugar which exists in the ripe pineapple as it stands on the plant is composed, on the average, of approximately fifty per cent sucrose and fifty per cent of invert sugar (d-fructose and d-glucose). This invert sugar has the same chemical composition as the invert sugar which is formed by the inversion or hydrolysis of sucrose. The hydrolysis of sucrose can be accomplished by heat, or by the aid of acid or by both. When the pineapple is picked the natural acid of the fruit begins at once to hydrolyze or invert the sucrose which is present. By the time the fruit has been picked twenty-four hours the sugar which existed while the fruit was on the plant has been modified so that the proportion of sucrose is materially reduced and the proportion of invert sugar (d-fructose and d-glucose) is increased by the amount produced by such inversion. These figures are more or less idealized as the total amount of sugar and the proportion of each constituent sugar depends upon the ripeness of the pineapple when it is picked and upon cultural conditions, soil and climate. The sugar in the commercial sugar syrup suitable for canning purposes as produced by our process consists, therefore, of the original invert sugar (d-fructose and d-glucose) which existed in the fruit, some of the original sucrose, which existed in the fruit (that which escaped inversion by the process) and the invert sugar (d-fructose and d-glucose) derived from the sucrose which has been inverted by the process.

In our process we contemplate the manufacture of citric acid direct from the fruit material without intermediate drying of the produced insoluble salts of citric acid by refining the freshly prepared insoluble salts of citric acid and also contemplate the manufacture of citric acid by refining the dried insoluble salts of citric acid by means of processes which are well known and old.

Throughout the entire process of manipulation of the pineapple material and the production of the various products the conditions of temperature must be proper and the control of the chemical reactions of the substances concerned must be proper or the products cannot be produced. This is particularly so with respect to the production of the commercial sugar syrup suitable for canning purposes.

Patent No. 1,197,442, September 5, 1916, issued to C. E. Burke, Berkeley, and D. E. Fogg, Oakland, California, is for a method of preserving fruit juices. It is general in character but stated to be applicable to pineapple. It is applicable to pineapple.

The pith of citrus fruit is separated from the outer part of the skin and from the pulp. This white material is treated with sulphur dioxide, pressed, and dried. The material is mixed with pineapple juice and a small amount of calcium carbonate added. A colloid mass is produced which clarifies the juice and subsequent pasteurization can be carried out without producing clouding.

Patent No. 1,121,007, December 15, 1914, issued to H. G. Ginaca, Honolulu, Hawaii, is for a process of treating pineapples by vacuumizing during the canning operation.

This invention relates to a process for treating fruit, particularly pineapples, during the operation of canning. Its object is to facilitate the syruping of vacuumized fruit and more perfectly incorporate the sugar in the fruit, thereby improving the quality.

Another object is to eliminate the passing of the cans after syruping through the old type of steam exhauster, which is the usual method of driving the air and gas out of the fruit and heating the fruit in the cans before the cans are sealed. A further
object is to eliminate syrapping the fruit while under vacuum, which requires complicated machinery for its practical accomplishment in a commercially successful manner.

The present process contemplates vacuumizing in a chamber the fruit at normal temperature contained in the open top cans, then admitting steam to fill the pores or cells of the fruit, from which the air and gas has been removed, with water condensed from said steam, the removal of the cans from said chamber, and then treating the fruit in these cans with a syrup, preferably consisting of refined cane sugar and water. In exhausting the air from the chamber, the air and gases in the cells or pores of the fruit are removed at the same time, in a well known manner, so that during the succeeding treatment by steam these cells or pores are filled with water condensed from the steam, thereby preventing air from entering the cells or pores when the vacuum is broken and the fruit removed from the chamber. Consequently, during the succeeding treatment with syrup, this water now in the cells or pores of the fruit readily takes up sugar from the syrup by endosmose or otherwise. The treatment by steam also heats the fruit which is desirable.

A vacuum is drawn to about 28 inches and the steaming of the fruit is continued until the temperature is raised to about 140° F.

Patent No. 1,214,598, February 6, 1917, issued to S. E. Shaffner, St. Louis, Missouri, is for "A certain new and useful marketable pineapple product." It consists of the horny skin with such flesh as may be adherent to it, finely comminuted, centrifugalized or pressed to remove surplus moisture, then dried at low temperature or in vacuum. This material contains the flavoring, nutritive, and medicinal qualities of the same parts of the fresh fruit without impairment and can be used as the basis for extracts or other preparations.

Patents Nos. 1,362,869, and 1,362,870, December 21, 1920, to M. O. Johnson, Waipio, Territory of Hawaii, are for a "Process of treating fruit-juice" and for a "Process of making fruit sirup."

The method is similar to that patented by Gore (No. 1,141,458) of the Bureau of Chemistry and dedicated to the public, but in this case made to apply more particularly to pineapple juice.

The part of the fruit not suitable for canning as sliced or crushed fruit is collected, pressed, and filtered of its coarser particles. The juice is chilled by passing through pipes in a brine tank and conducted into the freezing tanks in a refrigerating plant. The juice as it enters these tanks will test about 12 degrees on the Brix spindle. Upon freezing, ice forms on the outside next to the tank wall and the inner portion will remain liquid and contain the sugars and other soluble solids in a more concentrated form, the degree of concentration depending upon the time in the freezing tank. It has been found practical to stop when the juice is about two-thirds frozen and that remaining tests about 30 degrees on the Brix spindle. The cake of ice is opened, the concentrated juice saved, and the ice broken and centrifugalized to collect any juice which may be adherent to the surface.

Clarification is desirable as the raw concentrated juice is dark in color and rather viscous. Diatomaceous earth is preferable for the purpose and about 3 per cent added and diffused through it. The juice is heated rapidly to about 180° F., held for a short time and filtered, though this may be done after settling. The hot juice will pass through the filter more quickly than after it cools. It is run into sterile bottles and pasteurized at about 175° F. for 20 to 30 minutes. The pasteurizing temperature is not allowed to reach that used before filtering, otherwise some precipitate will occur.

The concentrated juice will be found to contain from 3 to 3.5 per cent
Acidity which is too high to be pleasing and it is recommended to add about 3 pounds of sugar per gallon, the addition being made during the heating and before clarification.

In the making of pineapple sirup used for canning, the steps are the same as for the preparation of the juice, but in addition, the citric acid is neutralized with calcium oxide, calcium hydrate, or calcium carbonate and the resulting calcium citrate filtered off. An alternative is to make the addition of lime before the first filtration.

Patent No. 1,458,427, June 12, 1923, issued to W. T. McGeorge, Honolulu, Hawaii, is for a general method of treating fruit juices which tend to darken and develop stale flavors. The process, however, has special application to pineapple juice, the treatment consists in adding to the juice about one per cent or less of fuller’s earth, aluminum silicate, agitating for fifteen minutes or more, then adding a colloid as gelatine at the rate of one-tenth to one per cent, and centrifuging at a speed which will remove the larger flocculent masses but not all the cloudiness. The gelatine or other colloid may be added either before or after centrifuging. The juice is bottled with absence of air, either vacuumized or carbonated, and pasteurized to preserve it.

Patent No. 1,764,491, June 17, 1930, issued to C. S. Ash, San Francisco, California, is entitled “Stabilized pineapple and process for producing the same.” The text is as follows:

The primary object of the present invention is to provide a process for stabilizing canned fruit, such as cooked pineapple, to maintain the taste and color of the product, and to prevent a deterioration of the product upon aging. Another object is to disclose and provide a canned pineapple capable of retaining its color and taste, and otherwise maintaining its stability and original properties upon storage for extended periods of time.

Hitherto, certain foods have been treated with carbon dioxide for the purpose of sterilization of fresh foods and beverages. The purpose of such process has been to substitute carbon dioxide as a preservative in place of heat or cold storage. In other words, the purpose of the prior processes of treating foods with carbon dioxide has been to preserve the foods in a similar manner to that effected by salicylates or benzoates so that the product is rendered imperishable; the microorganisms present being rendered inert or destroyed so that no decomposition takes place. In the treatment of canned fruits, such as cooked pineapple, it has been discovered that the pineapple can be made substantially sterile by the cooking or heating of the fruit to a temperature above 150° F. so that no bacterial action is present. However, after such sterilization of the fruit, it has been found upon aging to undergo certain changes, particularly in the case of pineapple. I have found that within a few months, a loss of the characteristic pineapple taste may be noted and a cooked or boiled taste appears and gradually develops. The loss in taste of the product is often accompanied by change in color from a lighter to a darker yellow or brown. It is, therefore, seen that in the preservation of pineapple, there is no need for the treatment of the same with sterilizing agents, such as carbon dioxide, or other materials mentioned, to sterilize the product itself, since substantially all bacterial action may be prevented by a simple process of heating. However, unless the sterilized pineapple is suitably treated, a substantial deterioration in taste and color takes place, and it is desirable to provide a method for the treatment of the fruit to prevent such deterioration of the sterile material. The treatment of fruit for this purpose is herein termed stabilizing the product.

I have discovered that by exhausting air from the uncooked pineapple or other fruit, so as to remove the natural intercellular atmosphere of the fruit, and then replacing such natural intercellular atmosphere with carbon dioxide, nitrogen or other suitable gas, the aging or deterioration of the subsequently sterilized fruit may be substantially prevented. I have also found that traces of sulfur dioxide added to the carbon dioxide or nitrogen also perform or aid in the function of preventing rapid aging or deterioration, thus further stabilizing the fruit.
Various further objects and advantages of the present invention will be understood from a description of a preferred type of a process embodying the invention. In the preferred mode of practicing the present invention, fresh uncooked or unsterilized pineapple, or like fruit, in open cans or other suitable containers, is placed within a closed chamber. This chamber is then exhausted with a suitable vacuum pump to remove the greater part of the air therein, after which the chamber is filled with carbon dioxide, nitrogen, or other suitable gas under pressure of, for example, 15 pounds per square inch. The process may be repeated by further exhausting the chamber and again filling with carbon dioxide, nitrogen, or other suitable gas at the same pressure. By this procedure, it is found that the fruit, even where otherwise too green, acquires a uniform golden color. After the fruit is thus treated, it may be syrumped and passed through an exhaust box in which it is heated by steam and then capped in accordance with the normal practice in cannery operations. After capping, the closed containers are then passed through a sterilizer where the containers and contents are subjected to temperatures of about 140° to 160° F. to sterilize the contents. The heating of syrumped fruit in open containers expands the syrup so that subsequent sterilization of the capped containers does not impose a great strain upon the containers. With the process of the present invention, no attempt need be made to seal the product in an atmosphere of carbon dioxide. Moreover, the process does not employ carbon dioxide or other gas as a medium for sterilizing the fruit or pineapple to prevent bacterial action, as in the usual orthodox heating treatment of the food the same is made sterile.

The basic novelty of the present invention resides in stabilizing the sterilized product by the replacement of the natural intercellular atmosphere of the fruit with a stabilizing gas, such as carbon dioxide, nitrogen or other suitable gas.

McCrosson Patent


By my method the pineapples are pared, cored and sliced as is now done, then the slices are saturated with sirup, by placing the slices in a mesh basket which is submerged entirely in a warm sirup in a tank that can be closed air tight. A high vacuum is drawn in the tank which removes the air from the slices, the vacuum is maintained only a few minutes, and air is then admitted and atmospheric pressure forces the sirup into the slices thoroughly saturating them.

The basket is removed and slices are drained to remove substantially all but the saturating sirup and put into cans or jars without adding any sirup. The containers are now sealed with a high vacuum. The cans or jars are now placed in a retort and processed at a heat sufficient to sterilize the product, say at about 180 degrees F., but less heat and time are required to sterilize as there is no sirup to be heated. In this manner the slices are sterilized in their own moisture and steam. After processing, the cans are cooled but here again the time is less, since there is no heavy sirup in the can to be cooled.

The advantages of my method are that all slices have the same appearance, all are saturated, which imparts a color that is highly desirable, and a better flavor of the product results since it was cooked in the absence of any air, so no oxidation could take place.

As there is no sirup in the can all the flavor is retained in the pineapples. The product is cooked in steam produced from its own moisture and juice during the sterilizing. The pines are sterilized quicker than if they were in heavy sirup which would have to be elevated to a higher sterilizing point. The same is true of cooling the cans after cooking, cooling being more quickly accomplished, and so as to eliminate any danger of overcooking such as is known as stack burning.

As illustrative of the advantages and economies obtained by my process, it may be stated that the weight of a case of 24 cans, No. 2½ size, would be about 15 pounds less, and this saving of freight is important. Further, as I use no packing sirup, there would be a saving of about 4½ pounds of sugar per case.
Scott Patent


In the practice of this invention the raw juice is first subjected to a treatment with a suitable alkali such as calcium hydroxide until it shows a definitely alkaline reaction and is then subjected to a treatment at a relatively low temperature for the purpose of removing the color forming bodies. This first separation step should be performed at a temperature of less than 125° F. and I find that temperatures of 60° to 100° F. give the best results in this connection. A temperature of approximately 70° F. is preferred. When separation is performed upon the alkaline juice at these reduced temperatures, it is possible to remove the color-forming bodies without simultaneously removing the calcium citrate. The alkaline treatment which is performed prior to this initial separating step should not be carried to excess, as the juice must be subsequently acidified and the expense incident to such acidification is, of course, greater in cases where a large amount of alkali has been added. Excellent results have been obtained when alkali was added until the juice showed a pH of approximately 8.5. In any case, it is highly desirable to add sufficient alkali to give a definitely alkaline reaction to the juice, as such alkaline juice lends itself admirably to the selective separation of the impurities present to the exclusion of the calcium citrate as above described.

The separation of the impurities from the alkaline juice may be performed in any known way, but it is preferably accomplished by means of a centrifugal separator from which the clarified juice is discharged while the impurities collected adjacent to the periphery of the centrifugal bowl. In this connection a centrifugal separator of the type shown in the patent to Nyrop No. 1,735,692 may be advantageously used, as a centrifuge such as described in that patent affords provision for the intermittent discharge of the solids without interruption of the operation of the machine. The bowl cake obtained in such centrifugal separation contains about 1.2% of the mass of the juice under treatment and consists of a gummy mass containing insoluble calcium salts of complicated organic acids. By centrifuging a juice treated with alkali to the degree described above in a substantially unheated condition, I have succeeded in removing the color forming and colloidal impurities to such a substantial degree that subsequent treatment in accordance with my process has enabled me to obtain the desired degree of concentration without the addition of sugar obtained from other sources.

The juice is next acidified until it shows an acid reaction of approximately pH 5.9 or 6. This acidification is preferably performed by means of citric acid as citric acid is a natural constituent of the juice, but other acids may, of course, be used in this connection. The acidified juice is then heated, filtered, and subjected to a treatment with vegetable carbon to remove further color forming bodies. This filtration is accomplished at approximately 180° F. The calcium citrate may be removed from the juice either simultaneously with the color bodies removed by the decolorizing carbon, or this filtration treatment may be divided into two steps in which the calcium citrate is first removed and the color bodies are subsequently removed by a decolorizing carbon treatment and second filtration. A centrifugal separator may also be utilized to obtain this final separation of the calcium citrate and decolorizing carbon from the acidified juice, if desired.

After the juice is treated as above described it may be evaporated under vacuum to the desired concentration, even where such concentration is very high, as described above. Juice treated in this manner is not subject to the objectionable decolorizing effect referred to above in connection with juices treated by currently known methods and it is therefore possible to concentrate it to a sugar concentration of 55% or 60% without encountering any objectionable color.


This is applicable particularly to pineapple juice and supplements the previous patent already cited by simplifying some of the steps in the recovery of the sugars and in separating the acids.
There are many species of native plums with a wide distribution in the north temperate zone, but those which have been developed horticulturally to produce the finest fruit, like their close relative the apricot, originally came from the Caucasus region. Domestication, while old, does not date sufficiently far back to be recognized in the Sanscrit. The numerous names applied to it indicate a rather extended culture at the time it was introduced into Greece by way of Syria, probably about 200 B.C. The Damson plum came in this way and is the earliest variety of which there is record. The plum, spread first by the Romans in their conquests and centuries later by the Germanic tribes, proved its adaptability to grow and thrive under the varying conditions found in Europe. The finest of the cultivated varieties, the Reine Claude, originated in France and was named in honor of the Queen of Francis I (sometime before 1547). Transported to England, it became known as the Green Gage, from its color and the name of the man who imported it, and after 400 years it still retains a very high place as well as the name.

The native plums have received attention from horticulturists but none have been developed equal to those of foreign origin. While the tree can be grown over a large section of the country, it is only on the West Coast that the fruit is borne in large quantities.

The tree is somewhat large and stronger than the cherry, with globular head, dark bark with a shiny purplish tint; leaves moderate in size, elongated, serrated on the edge; flowers white or pinkish, appearing before the leaves; fruit from an inch to two inches in diameter, globular or somewhat elongated, covered with a thin bloom. Varieties having a sufficiently high sugar content capable of dry-curing without removing the seed are known as prunes.

The principal canning varieties are the Green Gage, Yellow Egg, and Lombard. The Green Gage is preferred because it is more nearly spherical, the skin slightly tougher, the flesh firmer, the pit smaller, and the sugar content a trifle higher than in most other varieties. The Yellow Egg has a particularly full flavor. Of the dark varieties, the Idaho prune is especially pleasing when canned fresh. The texture and flavor are both good and it retains its rich plum color. There has been a marked increase in the canning of fresh prunes in the Northwest during the past few years; the Damson retains its place as the favorite variety for jelly making.

The plum pack is small, only about 150,000 cases annually.

Plums need to be hand picked and handled in lug boxes as other fresh fruits. The usual contract calls for delivery as follows: “All fruit covered by this contract shall be of good color, shape, quality, and in good condition for canning, at the state of maturity Buyer may require, free from doubles, worms, scab, frost rings, hail or rain damage, red streaks in flesh, windfalls, visible split pits, parasites, fungi, bruises, spray residue, gum or other imperfections.

“No. 1 Plums shall not be smaller than 12 to the pound, including stems. No. 2 Plums shall be from 13 to 20 to the pound, including stems.”
Factory Operations

The operations at the factory consist in first washing, then grading for size by running them over screens having openings of 32, 40, 48, and 56 thirty-seconds of an inch. The fruit is distributed from the grader to the filling tables, one size to a line. Those who do the filling also sort for quality, taking out any which may be irregular, green, over-ripe, or spotted from any cause. No trimming or peeling is done. The cans are filled level, depending upon the exhaust to soften them slightly so that the cover may be placed on without breaking the fruit. A sirup corresponding to the grade is added. If the exhaust be done at a moderate temperature to take about 12 minutes, the skin will not be broken nearly so badly as when the operation is pushed rapidly. Plain cans are used for the green and yellow varieties and enamel-lined for the red.

Effect of Varying Degrees of Sirup on Plums, Cut-out Weight of Fruit and Sirup

Yellow Egg plums. Weight of fruit 560 grams (20 ounces) in No. 2½ can:

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>866</td>
<td>532</td>
<td>344</td>
<td>10.5</td>
</tr>
<tr>
<td>10</td>
<td>894</td>
<td>598</td>
<td>396</td>
<td>14.7</td>
</tr>
<tr>
<td>20</td>
<td>896</td>
<td>582</td>
<td>314</td>
<td>16.5</td>
</tr>
<tr>
<td>30</td>
<td>896</td>
<td>583</td>
<td>313</td>
<td>21.8</td>
</tr>
<tr>
<td>40</td>
<td>917</td>
<td>550</td>
<td>367</td>
<td>25.7</td>
</tr>
<tr>
<td>50</td>
<td>917</td>
<td>500</td>
<td>417</td>
<td>31.0</td>
</tr>
</tbody>
</table>

Green Gage plums, 360 grams, No. 2 can:

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>590</td>
<td>341</td>
<td>249</td>
<td>9.6</td>
</tr>
<tr>
<td>10</td>
<td>600</td>
<td>335</td>
<td>265</td>
<td>13.5</td>
</tr>
<tr>
<td>20</td>
<td>600</td>
<td>335</td>
<td>265</td>
<td>16.7</td>
</tr>
<tr>
<td>30</td>
<td>617</td>
<td>331</td>
<td>286</td>
<td>21.9</td>
</tr>
<tr>
<td>40</td>
<td>634</td>
<td>325</td>
<td>309</td>
<td>26.8</td>
</tr>
<tr>
<td>50</td>
<td>645</td>
<td>323</td>
<td>322</td>
<td>32.3</td>
</tr>
<tr>
<td>60</td>
<td>658</td>
<td>321</td>
<td>337</td>
<td>36.2</td>
</tr>
</tbody>
</table>

Lombard plums, 360 grams, No. 2 can:

<table>
<thead>
<tr>
<th>Degree of Sirup</th>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>599</td>
<td>333</td>
<td>266</td>
<td>7.4</td>
</tr>
<tr>
<td>10</td>
<td>592</td>
<td>335</td>
<td>299</td>
<td>11.5</td>
</tr>
<tr>
<td>20</td>
<td>609</td>
<td>329</td>
<td>317</td>
<td>15.8</td>
</tr>
<tr>
<td>30</td>
<td>628</td>
<td>304</td>
<td>324</td>
<td>22.0</td>
</tr>
<tr>
<td>40</td>
<td>645</td>
<td>334</td>
<td>311</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Average of commercial packs:

<table>
<thead>
<tr>
<th>Weight of Contents</th>
<th>Weight of Fruit</th>
<th>Weight of Sirup</th>
<th>Degrees Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Gage, water</td>
<td>815</td>
<td>480</td>
<td>335</td>
</tr>
<tr>
<td>Yellow Egg, water</td>
<td>850</td>
<td>540</td>
<td>308</td>
</tr>
<tr>
<td>Green Gage, sec.</td>
<td>825</td>
<td>475</td>
<td>350</td>
</tr>
<tr>
<td>Yellow Egg, sec.</td>
<td>862</td>
<td>470</td>
<td>392</td>
</tr>
<tr>
<td>Green Gage, Std.</td>
<td>874</td>
<td>509</td>
<td>365</td>
</tr>
<tr>
<td>Yellow Egg, Std.</td>
<td>883</td>
<td>516</td>
<td>367</td>
</tr>
<tr>
<td>Green Gage, Ex. Std.</td>
<td>895</td>
<td>547</td>
<td>348</td>
</tr>
<tr>
<td>Yellow Egg, Ex. Std.</td>
<td>875</td>
<td>500</td>
<td>375</td>
</tr>
<tr>
<td>Green Gage, Extra</td>
<td>925</td>
<td>495</td>
<td>430</td>
</tr>
<tr>
<td>Yellow Egg, Extra</td>
<td>910</td>
<td>480</td>
<td>430</td>
</tr>
</tbody>
</table>
Grades

Fancy—Fruit to be of very fine quality, free from blemishes serious for the grade and uniform in size. In sirup, 55% sugar when packed.

Choice—Fruit to be of fine quality, free from blemishes serious for the grade and uniform in size. In sirup, 40% sugar when packed.

Standard—Fruit to be of good quality, reasonably free from blemishes serious for the grade and reasonably uniform in size. In sirup, 25% sugar when packed.

Seconds—Trade designation “Seconds.” Fruit to be tolerably free from blemishes serious for the grade and tolerably uniform in size. In sirup, 10% sugar when packed.

Packed in water—Trade designation “Water.” Fruit to be tolerably free from blemishes serious for the grade and tolerably uniform in size.


Composition

The composition of several types of plums is given in Circular No. 50, Department of Agriculture, as follows:

<table>
<thead>
<tr>
<th>Components</th>
<th>European Type Per Cent</th>
<th>Damson Type Per Cent</th>
<th>Japanese Type Per Cent</th>
<th>American Type Per Cent</th>
<th>Prunes (fresh) Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>15.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>86.1</td>
<td>78.8</td>
<td>83.9</td>
<td>87.6</td>
<td>76.5</td>
</tr>
<tr>
<td>Protein</td>
<td>.7</td>
<td>.7</td>
<td>.7</td>
<td>.5</td>
<td>.9</td>
</tr>
<tr>
<td>Fat</td>
<td>.1</td>
<td>.1</td>
<td>.1</td>
<td>.3</td>
<td>.2</td>
</tr>
<tr>
<td>Ash</td>
<td>.47</td>
<td>.67</td>
<td>.4</td>
<td>.42</td>
<td>.6</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>12.6</td>
<td>14.9</td>
<td>11.2</td>
<td>21.8</td>
<td></td>
</tr>
<tr>
<td>Fiber</td>
<td>.4</td>
<td></td>
<td>.4</td>
<td></td>
<td>.5</td>
</tr>
<tr>
<td>Sugars</td>
<td>8.5</td>
<td>8.7</td>
<td>7.98</td>
<td>13.3</td>
<td></td>
</tr>
<tr>
<td>Acid as malic</td>
<td>1.46</td>
<td>2.02</td>
<td>1.69</td>
<td></td>
<td>.98</td>
</tr>
<tr>
<td>Heat units per 100 g.</td>
<td>54.</td>
<td></td>
<td></td>
<td>49.5</td>
<td>92.6</td>
</tr>
<tr>
<td>Heat units per lb.</td>
<td>225.</td>
<td></td>
<td></td>
<td>420.</td>
<td></td>
</tr>
</tbody>
</table>

Label Weights

Fancy (Sp. Gr. 1.10): 8Z Short, 8 ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs. 14 ozs.

Choice (Sp. Gr. 1.08): 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

Standard (Sp. Gr. 1.06): 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

Seconds: No. 2½, 1 lb. 12 ozs.

Water (Sp. Gr. 1.04): No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 8 ozs.
The prune, as already indicated, is a variety of plum having a high sugar content adaptable to cure by drying. It is ordinarily distributed in commerce in a partially dried form, sun-dried if cured in the orchard, and evaporated if cured by mechanical means. The latter is taking the place of the former, even where sun drying is easy, as evaporation is subject to close control and is by far the more sanitary method. Canned prunes are gradually growing in favor and now exceed canned plums at a ratio of about 6 to 1.

The fresh fruit is generally large, dark blue, fairly firm, inclined to be rather dry, rich in sugar, and with only moderate acidity. Production is on the West Coast and in Idaho.

Within recent years the fresh stock has been canned to compete with the dried product. It makes an excellent breakfast dish, differing from the regular canned plum and canned cured prune. The preparation is simple. The fruit is taken when fully ripe and ready to drop from the tree, graded for size on any type of fruit grader, then treated to a lye bath the same as in the preparation for drying. This is not a necessary step but adds to the appearance of the finished product by lessening the amount of splitting of the skin. The lye solution found best is in the ratio of one pound of lye to twelve gallons of water, kept hot so that it acts in from 8 to 10 seconds, and is then washed off under strong sprays. The fruit may be run onto the regular canning tables or it may be filled into cans directly from the conveyor belt. A 25 to 30 degree sirup is added. The important step is to exhaust well at from 180° to 190° F. for from 12 to 15 minutes, and to cook from 20 to 25 minutes. Fresh prunes as well as dry prunes are more likely to develop springers than the green gage or egg plums, hence the need for giving extra time in exhausting. They should be cooled immediately after cooking.

Half-cured prunes have a character and quality which differs from either the fresh or dried fruit and which can be retained to a considerable degree by canning when at the proper stage. A patent, No. 830,407, issued September 4, 1906, to J. L. Bowers, Monticello, California, contains the following:

The improved process constituting the subject-matter of the present invention consists in partially drying the prunes, dry-packing the fruit in partially-dried condition in cans, jars, or other receptacles, hermetically sealing the receptacles, and finally subjecting the receptacles containing the fruit to the action of heat to sterilize the fruit.

In carrying my process into effect I preferably take the fruit in its natural state and place the same in pans or trays and subject it to the action of solar or other dry heat until partially dried, then drypack the fruit in suitable receptacles, which are next hermetically sealed and finally boiled or otherwise treated with heat for sterilizing the fruit.

By my process there is a material saving in the matter of preserving the fruit as compared with the old method, while at the same time liability of the prunes becoming mouldy, wormy, or undergoing fermentation is wholly obviated, and the fruit is received by the consumer in a perfectly natural and highly desirable state.

Cured prunes are also canned ready to serve and it is this product which is meant when no qualifying term is used. The size of prune most used is the 50 to 60 or the 60 to 70 to the pound as these give a large and attractive product on the cut-out.
The prunes are first washed, then run through a dried fruit processor, held about 4½ minutes in water near boiling, after which they are sprayed to cool them. They are inspected and any split or defective fruit taken out, filled into cans to about one-half their capacity, and the fill completed by adding 25 per cent sirup. The prune absorbs the sirup and thus produces the proper effect on the cut-out. Where the equipment permits, it is claimed that clipping the cover on is an advantage when the cans enter the exhaust box, though this is not at all necessary. The exhausting is the most important step, taking from 20 to 25 minutes at 200° F. One practical method to obtain this result is to run the exhaust box full, then stop the travel and let the cans stand for the full time. After sealing, a cook of from 40 to 60 minutes is given to produce plumping and the proper degree of tenderness. This is preferable to cooking only to sterilize the contents and then stacking the cans hot or putting them in cases. This latter was the old way but resulted in many springers. The prunes may be made tender in less time by using a temperature of 220° to 222° F. but with some change in flavor.

The packing is done in No. 1, No. 2, No. 2½, and No. 10 cans.

E. M. Mrak and P. H. Richert (Bulletin 508, University of California) give a slightly different method. The prunes are first washed in cold water, then blanched from 5 to 10 minutes at boiling temperature, filled into the cans, and a sirup testing from 20 to 30 degrees added, but leaving a half inch or more of head space. The cans are exhausted for 10 minutes at 210° F., then cooked at 212° F. for all sizes up to and including No. 2½ for 1 hour and No. 10 cans for 1½ hours. The cans are cooled for 3 minutes.

Dry Canning

Prunes are also canned without added water or sirup. They are washed and run through a regular fruit processor in from 4 to 4½ minutes, then sprayed. Thus far the steps are the same as for canning with sirup. The fruit is filled into the cans by weight; No. 2 flat, 1 pound; No. 2½, 1 pound 12 ounces; and No. 10, 5 pounds. The covers are loosely attached and the cans exhausted for 25 minutes at 205° F., then are sealed, run through an agitating cooker for 10 minutes and air-cooled.

W. V. Cruess and E. Mrak give the following as another method for packing prunes without sirup: Prunes are graded for 50 to 60 per pound, washed, dipped in boiling water for 9 minutes, drained, pressed into lacquer-lined cans, the lid clinched on, and run through an exhaust box at 210° F. for 20 minutes, then sealed. No additional sterilization is required. The fill for the 8 ounce can is 8 ounces; for the No. 1 flat, 12.5 ounces; and for the No. 1 tall, 16 ounces.

Packing in glass makes an attractive package. After filling, the jar should preferably be vacuumized and then given a process until the center reaches more than 175° F. (Western Canner. Aug., 1930, p. 6-7.)

The difficulty with canned prunes, either with sirup or dry, is the development of hydrogen swells. To avoid this, it is recommended that the prunes be canned on orders so as not to take the chance of holding goods in stock for several months. If held, they should be kept in cool dry storage.

Standards

Prepared prunes in sirup to be properly matured, clean, sound fruit, dried in accordance with the usual commercial practice; to be whole, sepa-
rate, and of good color, odor and flavor. The count, after packing and after
draining in the standard manner indicated, not to vary in any one parcel in
excess of 10 to the pound; thus, for example, the count in any one parcel
to be within a range of 20 to 30, 30 to 40, 40 to 50, etc. Cans to be well
filled with fruit and packed with sugar (sucrose) sirup testing not less
than 20% sugar when packed. The minimum drained weights 30 days after
packing to be as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; Eight ounce</td>
<td>6 1/4 ozs</td>
</tr>
<tr>
<td>3 1/4&quot; Eight ounce</td>
<td>6 1/2 ozs</td>
</tr>
<tr>
<td>Picnic</td>
<td>8 ozs</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>12 ozs</td>
</tr>
<tr>
<td>No. 2</td>
<td>15 ozs</td>
</tr>
<tr>
<td>No. 2 1/2</td>
<td>22 ozs</td>
</tr>
<tr>
<td>No. 300</td>
<td>79 ozs</td>
</tr>
</tbody>
</table>

At the time of packing the weight usually runs 4 to 5 per cent less than
the above and increases gradually for 30 days or longer.

Label Weights
(Sp. Gr. 1.10). 8Z Short, 8 ozs.; 8Z Tall, 8 3/4 ozs.; Picnic—No. 1
East, 11 ozs.; No. 300, 15 1/2 ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb.
1 oz.; No. 2 Special, 1 lb. 4 ozs.; No. 2, 1 lb. 5 ozs.; No. 2 1/2, 1 lb. 14 ozs.;
No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 12 ozs.; No. 10, 6 lbs.

QUINCE
Cydonia oblonga

This fruit tree is native to the greater part of southern Europe, the part
of western Asia lying directly eastward, and the northern part of Africa.
The fruit held a very important place in ancient times, especially with the
Greeks and Romans, but as other fruits responded more readily and gener¬
ously to horticultural treatment, this one lost in favor and at present has
only a small place in the garden and orchard. It is probably more esteemed
and used in Argentina than in any other country.

The quince is closely related to the apple but the tree is smaller, generally
growing from 8 to 15 feet in height, is rough, and the branches irregularly
distributed. The leaves are roundish, more or less pubescent on the under
side; flowers early, with the fruit globular or pear-shaped, most often
somewhat irregular in contour, color green to yellowish, hard with many
sclerenchyma or stone cells like the Kieffer pear, are highly odorous, have
poor flavor while raw but are improved greatly by cooking. The flavor,
like the aroma, is so strong that the fruit is often used to flavor other fruit
such as the apple, or to be used in mixtures or compotes. This quality has
been commented upon since the earliest times when the quince was cooked
with honey and made into a preserve, and much later, when sugar was in¬
troduced, the cooking of the two together gave rise to the term marmalade,
the latter being derived from Marmelo, the Portuguese for quince.

There is very little quince packed in this country except in the form of
preserve, and as stock to be used for flavoring other products. The methods
are the same as for apples and require all hand work.

The utilization of the fruit in Argentina is in the form of paste. The
method of preparation, as supplied to me by J. P. Zavalla, is as follows:

The washed fruit is placed in barrels, or in baskets, and set in a retort,
the cover closed though not tight. Steam is turned on for three-quarters
of an hour, or longer if necessary, to make the quinces soft. They are then run through a pulping machine while hot which separates the skin, cores, seeds, and hard parts and reduces the fleshy part to a smooth consistence. This pulp is then placed in jacketed kettles and cooked for 30 minutes to cause partial evaporation. Eighty pounds of sugar is then added to 100 pounds of the pulp and the cooking continued for 15 minutes more. An agitator is necessary in order that the cooking be uniform and to prevent sticking to the kettle. When finished, the product has a heavy consistence and a light pinkish color. Other flavoring, especially lemon juice, may be added to give it some tartness. It is packed in No. 2½ cans and given a short heating, 5 minutes at boiling to insure against infection from the can.

Quince paste is also made from pulp concentrated until it has a heavy consistence and then turned into shallow vessels to cool, after which it is cut into slices with a knife.

Composition

The composition of quince, as given in Circular No. 50, is as follows:

<table>
<thead>
<tr>
<th>Components</th>
<th>Fruit Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>85.3</td>
</tr>
<tr>
<td>Protein</td>
<td>.3</td>
</tr>
<tr>
<td>Fat</td>
<td>.1</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>13.9</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.8</td>
</tr>
<tr>
<td>Sugar</td>
<td>6.3</td>
</tr>
<tr>
<td>Acid as malic</td>
<td>.87</td>
</tr>
<tr>
<td>Calories per 100 grams</td>
<td>57.7</td>
</tr>
<tr>
<td>Calories per pound</td>
<td>260.</td>
</tr>
</tbody>
</table>
THE CANNING OF VEGETABLES

"Canned vegetables are sound, properly matured and prepared fresh vegetables, with or without salt, sterilized by heat, with or without previous cooking in vessels from which they take up no metallic substance, kept in suitable, clean, hermetically sealed containers, are sound and conform in name to the vegetables used in their preparation."

THE ARTICHOKE

*Cynara scolymus*

The artichoke, globe artichoke, or flowering artichoke, is known in French as *artichaut*; German, *artischoke*; Italian, *carciofo* and *aticioca*; Portuguese, *alcachofa*; Spanish, *alcachofa*; and Arabian, *ardhischoki, hirschuff*. The Oxford Dictionary gives an exhaustive list of the terms used to designate this plant of which the following excerpt is of most interest in tracing its English antecedents: "The phonetic genealogy seems to be: Sp. Arab, alkharshof (a O Sp. alcarchofa, O It. alacricchio). North It. arcicioffo arciciocco (whence Eng. archychock), articiocco. Eng. artichoek. Like other words of foreign origin much influenced in its form by popular etymology."

Gibault, in his *Histoire des Legumes*, traces the origin from the scientific side. The plant is known botanically as *Cynara scolymus* and belongs to one of the largest families of plants—the Compositae—noted for the number of weeds and including such well-known and almost universally distributed species as the dandelion, sunflower, goldenrod, and thistle. While the particular plant under consideration is little known in this country, as it occurs only under cultivation and that in few places, it is common in Southern Europe about the Mediterranean. It is very closely related to the cardoon, *Cynara cardunculus*, so closely, in fact, that most botanists now believe they have a common origin. The plants are so similar in appearance in the early stages of growth that they are difficult to distinguish at a distance of a few feet. The relation to the thistle is close, and the appearance also very similar, the artichoke being the larger and coarser, but not armed with sharp spines as are the common and Canadian thistles. Other than the form and arrangement of the individual florets it has little in common with the Jerusalem artichoke, *Helianthus tuberosus*, though the latter belongs to the same family; and it has still less with the Japanese artichoke, *Stachys sieboldii*, which belongs to a different family. These two artichokes are used for their tubers and not for the flowering parts. According to M. Lemery, a French physician and scientist of the early eighteenth century, the species name has a legendary side: "The Latin word Cinara, which signifies an Artichoak, is derived, according to the opinion of some, from the name of a maiden called Cinara that the ancients fables say was changed into an Artichoak; or else a Cinere, ashes, because as we have already remarked, Artichoaks grow easily in those places that are covered with ashes. Artichoak in Latin is called Scolymus, from the Greek, meaning rough and pricking, because it pricks when it is touched."
Origin

The place of origin of the globe artichoke is not definitely known, though it is usually ascribed to the neighborhood of the western Mediterranean in southern Europe and northern Africa. It has been known in that region longer than in any other, and has never been found growing wild in any other part of the world. The history, as usually developed from the botanical side, is that Pliny noted it in use by the Romans, who esteemed it as a luxury. The terminology which he used is not perfectly clear, and later writers upon plant economics believe that he refers to the cardoon and that the artichoke came into use at a much later date. Instead of a separate species, they consider the artichoke to be a variety of the cardoon in which the flowering parts have become especially developed by selection and cultivation, whereas in the present cardoon the petiole and midrib have undergone the development until the leaves resemble celery, especially after blanching. The evolution is attributed by some to Italian gardeners during the latter half of the fifteenth century. As further evidence of a common parentage for these two plants, it is stated that the artichoke is never found growing spontaneously, but always in gardens or directly escaped from cultivation. Its range of growth is a little more restricted than that of the cardoon. Both are perennials, though under cultivation the cardoon is treated as an annual. Dodoens, a botanist of the sixteenth century, first suggested the common origin of these plants, and was later supported in this view by De Candolle and others.

Lebault, who is probably one of the most reliable investigators of the history of foods and their preparation for the table, states that the artichoke was known to the Greeks and used by them 600 B.C., and by the Romans before the Christian era, which would indicate that the plant ranged farther east and was used at an earlier time than accorded to it by botanists. Galen, the Greek physician who taught medicine in the second century, recommended that the artichoke be used in certain diseases, and Athenæus, the Greek scholar who wrote the Deipnosophists about 250 A.D., says "Artichokes were often eaten," but adds that the vegetable which the Greeks call an artichoke is apparently the same as what the Romans call carduus. Since both the heads and parts of the stalk of the artichoke and the stalks and leaf stems of the cardoon were used in cookery, one cannot be sure that a distinction was made between them. There is a strong presumption that a difference was recognized, as the heads were esteemed as a delicacy like asparagus, and this could not well apply to the cardoon. After this time there is a period in which no reference is made to either plant in cookery, but when mention next occurs, the uses of the two are clearly indicated. If the earlier references are really to two plants, this would negate the theory that the artichoke is of recent origin, though it may have the same parentage as the cardoon.

Distribution

Owing to the peculiar selective habits of the plant as to soil and climate for good growth and the relatively small amount of edible material produced, it naturally fell into the luxury class of foods, and its cultivation extended very slowly. It was cultivated in Spain and southern France and as far north as Paris in 1479, and this last has proven to be about the northernmost limit for growth in that country. Even there it required a
good deal of winter protection. It was introduced into England in 1548, but has resisted all attempts to acclimate it.

The Spaniards carried the artichoke to South America and Mexico when they established colonies in those countries, and at a later date it became a common garden plant on the west coast of Ecuador, Peru, and Chile, in parts of Brazil, and in Argentina. It continues to be one of the vegetables held in high regard for salads and for other purposes, and thus it has come about that a number of varieties have been developed especially suited to the local conditions in those countries. It was brought to this country a number of times and tried in the South, especially around New Orleans and along the Gulf, and also grown as far north as New York State, but in the latitude of the latter it requires so much winter protection that few gardeners take the trouble to grow it. No real headway was made in its cultivation until it was planted along the West Coast in the eighties or nineties of the last century. It is not known who brought the seeds or plants to California, but it is generally credited to Italian gardeners who were familiar with the plant in their native land and who recognized the local conditions as favorable for growth. They cultivated the plant first for their own use and that of their fellow countrymen in nearby cities, so that for a few years it occurred only in limited amounts in the markets. The first carload shipment was sent east in 1904, since which time there has been a steady growth in production and distribution.

How little the artichoke is grown and how little it is known in this country is reflected in the *Experiment Station Record*, the first citation of station work being done in Idaho in 1898, the only bulletin published being from the New York State Station in 1917, and a few brief notes from other stations.

The Plant

The artichoke is a perennial, large, coarse like a thistle but without the sharp spines of the latter. The leaves are numerous and grow to a length of three to four feet; the flowering stalks are erect and grow to a height of six to eight feet, producing from 25 to 75 buds or flowers when allowed to mature. The first buds develop on the central and tallest stalks and then on the next lower as the season advances. The entire plant is covered with a coarse pubescence which gives it a gray appearance.

The true flowers are small, numerous, closely compacted on a base an inch or more in diameter, surrounded by several rows of large bracts or scales which completely envelop the flowering head while in the immature state, but open and display a conspicuous purplish head like a giant thistle when mature. The immature head is globular, or in some varieties more or less conical in shape, and from two to four inches in diameter, which gives it the name Globe Artichoke. These heads are commonly referred to by gardeners and in the trade as “chokes.” The base of each scale is thickened and contains a small portion of delicate edible material, and likewise a thickening of the base beneath the florets, all of which is edible. This portion is called the bottom, or sometimes improperly the heart. It is from one to two inches in diameter and a half inch or more in thickness.

In spite of its coarse, rough, hardy appearance, the plant is sensitive to cold and cannot be propagated in the North without protection. The leaves
are easily frosted and the roots killed either by freezing or smothering by mulch. It is also injured by high heat and drought as under these conditions the edible parts become fibrous and woody and so lacking in flavor as to be useless. It develops to perfection only where the season is long, moderately cool, and visited by frequent rains or fogs. The plant makes a rank growth so needs a rich but not soggy soil. These requirements limit the ideal growing conditions to comparatively small areas, and in this country all of these requirements are most nearly met in a narrow strip along the Pacific Ocean south of San Francisco. The acreage planted in this section has increased from garden patches in 1900 to about 11,000 acres in 1925, the latter found to be considerably in excess of the demand. The shipments amounted to 1,155 carloads or probably 98 per cent of the total amount found in the fresh market. Recently plantings have been made in Texas which are promising.

The conditions in Chile are similar to those on the West Coast and fine artichokes are produced. There they are used commonly the same as other vegetables.

Culture

The plant is either grown from seeds or shoots, preferably from the latter, taken from plants selected for the good qualities in the buds. They are planted from five to six feet apart in the row and in rows eight to ten feet apart, depending upon the character of the land and its exposure. No buds are harvested the first year, and it is not until the third or fourth year that they produce a maximum crop. They are ready to be dug up the seventh year, for if kept longer, the buds diminish in size. Abroad the buds are harvested the second year and the plants taken up at the end of the fourth or fifth year.

The normal time of flowering is in July, but it is advantageous to cut the plants back in the spring so as to delay the development of buds until December to get the maximum crop about February, when other green vegetables are off the market. There are only two important varieties grown here, the Paris and French Green. In France there are only a few varieties, the *Tres vert de Laon* being the one most used for canning, and *Vert de Provence* and *Cantis de Bretagne* as second and third choice. In Chile there are about fifteen varieties.

Early Culture

A bit of sixteenth century lore concerning the culture of the artichoke occurs in *L’Agriculture et Maison Rustique* a famous work that had 20 editions from 1564 to 1702, and was translated into German and Italian by Charles Estienne. “Artichokes are sown in August, February, March, and April, in full moon, and replanted so as to have them fine. They must be well worked, manured, and watered. Cardes or cardoons are cultivated like artichokes. One also plants them in October so as to have them fecund and fertile, using only cuttings with the largest leaves from those plants that carry the finest fruit, and also many of the largest stems from the middle, which are of no use after the offsets are taken. Replant, as one is accustomed, set the stems about a foot into the well-manured earth, the leaves upright and showing, and bound with a little straw, the stems prostrate and well covered. Keep them thus, wetting at times if the weather
be dry so as to bring forth the stem. Transplant the offshoots to manured ground, well proved, and covered in winter with straw, flax, or hemp to guard against freezing. The following year they will develop fruit.

“If artichokes without spines are desired, the pointed end of the seed must be rubbed against a stone and broken, or some seed, in the manner of a graft, be placed in the root of lettuce, which ought to be unbroken and small pieces taken so that in each piece is grafted an artichoke seed, and thus plant.

“Artichokes of fine fragrance can be had if the seed be put to soak for three days in juice of roses, or lily, or oil of laurel, or lavender, or other odorous juice, then dried and sowed thus. So far there is nothing to indicate that the seeds are injured by the oils. Artichokes with the odor of laurel can be had if a hole be made in a laurel seed and an artichoke seed put in it, and plant thus. The artichoke will be sweet if the seeds are soaked in milk before planting, renewed two or three times as it sours, or honey used, then dried and sown.

“The Italians eat them in the morning while they are still tender with some bread and salt.”

Medicinal Uses

A very early use of the artichoke was as a medicine that was highly extolled by Galen. He recommended that the globes and other parts be boiled with wine, olive oil, and coriander seed. The decoction was a favorite febrifuge before the advent of quinine and is said to be used for the same purpose at present among the poor of Italy, Spain and France. It contains tannin and is slightly astringent, making it useful in intestinal disorders, particularly infantile diarrhoea. It is mildly diuretic.

Fourteen centuries later the use and physiological effect of the artichoke was treated in Le Thresor de Sante (1607) as follows: “The Greeks called them scolymus and cinara, which are at any rate two kinds of thistles, one cultivated and the other wild. The cultivated is a species of thistle that grows in the gardens, the leaves of which are brought together, covered with earth in the winter and blanched, and the stems are pleasant to eat. The heads are produced all summer and even longer. The interior, which is the bottom, is parboiled, and when pierced with clove and cinnamon is put in paste with fresh butter, beef marrow, sugar, and rosewater. The wild also forms a head. Both have the virtue of heating and being diuretic. They are suitable food and promote the appetite but cause flatulence. The tenderest portion of the root can also be eaten with bouillon or in salad like asparagus. The Genoese call them arcoe. The stems and leaves can be kept all winter like chards which are of the same quality. To keep the heads, they are dried little by little in the sun or in an oven. They are compressed in a dry place to keep from moulding, and are cooked for eating.

“The ribs of lettuce and artichoke are ordinarily preserved. Those of lettuce should be picked a little after they come out and are tender, not at seed time when hard. The skin is peeled off and they are boiled until tender; then dried in the shade between two cloths after wiping dry; they are re-cooked in sugar sirup to keep until needed. To make a dry confection they are treated like rind. The chards and ribs of artichokes should be preserved in the same way, except in place of sugar there is used clarified white honey
from Provence or Languedoc, as honey is more suitable than sugar for keeping in sirup."

**The Place of the Artichoke Among Foods**

As previously indicated, this vegetable is known to relatively few native-born persons, its use being largely confined to those who have come from southern Europe or who have become acquainted with their style of cookery. The artichoke is not eaten primarily for its nutritive value or as a source of energy, but as a delicacy, and a taste has to be acquired for it by cultivation. Gibault quotes early writers to the effect that for a long time the artichoke was a rare and costly vegetable. It was not on the table of the poor, said Bruyèrein-Champier (sixteenth century). It was found only in the gardens of good houses. According to Dalechamps, "It was only at sumptuous banquets that it was served, provided that it was out of season." Its present place in cookery has been aptly expressed by Madame Renée Raymond in discussing it as a canned vegetable. "It is not a common kind of conserve, as string beans or peas. It is more the property of the refined kitchen, as the bottoms of artichokes are used in the preparation of very choice dishes, chicken in Demidoff style, pigeon in the Paris style, etc.; their use is simply reduced to that of an accompaniment, such as for soft boiled eggs covered with rich sauce, truffles, etc.; one can also stuff them with the white part of the chicken, etc. In this last case they are served on toast." The recipes, old and modern, support this view. Its distinctive food properties are said to be due to the high iron content and other mineral salts and to the presence of iodine.

**Composition**

There is little in the literature relative to the composition of the artichoke. Tibbles in his "Foods, Their Composition and Manufacture," 1912, gives the following: "They are boiled in plain water or in milk, and are eaten with white sauce, pepper and salt, or with other condiments. They are diuretic. Analysis shows that they contain inulin and the ordinary constituents: Water 79.5, protein 2.6, fat 0.2, carbohydrate 16.7, fibre 0.8, salts 1.0 per cent."

The most complete analysis is that found in the report of the California Agricultural Experiment Station, pp. 110 and 111, 1921. It is as follows:

"**Nutritional Study of the Globe Artichoke**

"A nutritional study of the Globe Artichoke was made by Jaffa and Goss in order to answer satisfactorily requests from institutions and hospitals regarding the food value of this vegetable. The analytical data are presented in the following tables:

<table>
<thead>
<tr>
<th>Physical Analysis</th>
<th>Weight</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base or “cheese”—edible portion (average 5)</td>
<td>27</td>
<td>12.7</td>
</tr>
<tr>
<td>Scales—edible portion (average 5)</td>
<td>74</td>
<td>35.2</td>
</tr>
<tr>
<td>Refuse</td>
<td>109</td>
<td>52.1</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
<td>100.0</td>
</tr>
</tbody>
</table>
CHEMICAL ANALYSIS

<table>
<thead>
<tr>
<th></th>
<th>Refuse</th>
<th>As pur-chased</th>
<th>Edible</th>
<th>Entire</th>
<th>Artichoke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edible portion</td>
<td>81.15%</td>
<td>35.52%</td>
<td>87.70%</td>
<td>52.10%</td>
<td>85.80%</td>
</tr>
<tr>
<td></td>
<td>3.82</td>
<td>1.04</td>
<td>2.56</td>
<td>1.39</td>
<td>2.90</td>
</tr>
<tr>
<td></td>
<td>1.34</td>
<td>0.32</td>
<td>0.79</td>
<td>0.45</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>0.16</td>
<td>0.39</td>
<td>0.20</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>3.17</td>
<td>1.26</td>
<td>3.12</td>
<td>1.50</td>
<td>3.13</td>
</tr>
<tr>
<td></td>
<td>10.02</td>
<td>2.20</td>
<td>5.44</td>
<td>3.26</td>
<td>6.81</td>
</tr>
</tbody>
</table>

The physical analysis shows that the waste or refuse from this vegetable is less than was anticipated. Several individual samples were analyzed, showing a refuse less than 50 per cent. The waste, therefore, for the artichoke is about the same as that recorded for fresh lima beans, green peas, pumpkins, and squash, and less than that found for green corn and cabbage sprouts.

The protein content of the edible portion is much higher than is usually found in a vegetable with such a percentage of water, while the mineral matter is that usually noted for such vegetables.

The figure for nitrogen-free extract, which includes the soluble carbohydrates, is high, but a considerable proportion of this carbohydrate material consists of inulin, which is not well utilized by the human system. At the same time it is not, like starch, converted into glucose, and, therefore, it would be recommended for diabetics, even if only for the sake of supplying bulk. This is a very important item in the diet for such patients.

Canning

Since the artichoke is held in favor by those who are fond of good food and are able to gratify their desires in this respect, it is but natural that it should be canned when in its prime condition as are other vegetables. It affords the most satisfactory method known for conserving it at present to make it available where it cannot be grown. Drying results in a toughening and hardening of the fiber to such a degree that it cannot be even approximately restored and pickling changes its natural flavor beyond recognition.

The artichoke was first canned by Appert, and that mode of preservation has been used since, but on a small scale. The canned product has never been a real factor in commerce, and while it would be unreasonable to expect it could take a place among the staples, it is deserving of being better known and having a wider usage. This product presents some problems in preparation which are different from those of other vegetables, and as a result it has not received the attention necessary to determine the most economical methods to follow nor those giving the best results. The processes, both foreign and local, are given to show the development which has taken place and to serve as a basis for future work. It will be generally understood that most of the foreign processes are not permissible here because of the use of chemical agents for bleaching.

Artichokes used for canning are preferably obtained from the early buds, or at least before the crop is half gathered. The early buds have the
better qualities, are more fleshy, and have less fiber. They are gathered when full size, but before the scales begin to open. The stem is left two inches or more in length; as the extra length prevents drying, there is less blackening of the bottom and less tendency to bitterness. The buds do not undergo as rapid change as asparagus, beans, and other succulent materials, nevertheless they need to be handled promptly in order to present the best appearance, crispness, and the normal characteristic flavor.

**Foreign Methods**

Appert, in his first edition, gives the following:

"**Artichokes Whole:** I take them of average size; after having removed all the unnecessary leaves and pared them, they are plunged into boiling water and then into cold water; after they have drained, they are put in wide-mouthed bottles, closed, etc., and then into the water-bath to receive an hour's boiling, etc.

"**Artichokes in Pieces:** The fine artichokes are cut into eight pieces; the outer leaves are removed, only a few being left. They are plunged into boiling water, then into cold water; when well drained they are put on the stove in a casserole, with a bit of fresh butter, seasoning, and fine herbs; when half-cooked they are removed from the stove and put to cool; then they are put in a wide-mouthed bottle, closed, luted, tied, etc., and put in a water bath to boil for a half hour, etc."

These directions remain unchanged in the fourth edition, published in 1831, and are later repeated by Leon Krebs in 1886.

Faucheux, in 1851, gives practically the same method for whole artichokes, and also gives a method for hearts instead of pieces. He advocates the use of a small amount of vinegar in the water for the preliminary soaking, and also a small quantity of alum. Neither are recommended after the blanching. This seems to be the first time that an acid is employed to prevent the formation of the objectionable dull gray color due to preparation.

Corthay, in 1889, gives the best description of the commercial preparation of artichokes, and figures the Cotte power knife used for trimming the heads so as to conserve space in the cans. His work is marred for our purpose in that it is based upon the use of sulphurous acid for bleaching and preventing the darkening of the cut surfaces.

Gouffe, in his masterpiece upon conserving, in 1900, gives the following procedure:

"**Artichokes Whole:** Prepare three artichokes for each can; remove the outer leaves and cut two centimeters (one inch) from the extremity of the outer leaves; trim the bottoms; blanch until one can remove the straw (florets); sprinkle with lemon juice; put in fresh cold water; drain; place in cans; fill with lightly salted water and add lemon juice; close the cans; boil two hours in a water bath."

"**Artichoke Hearts:** Take fresh artichokes, remove the hard leaves; blanch; remove the straw (florets); trim the bottoms to equal size; sprinkle with lemon juice; make a dressing with 10 grams of butter, 30 grams of flour; wet with 2 liters of water, the juice of 2 lemons, and 10 grams of salt; cook 20 minutes, put into the artichoke hearts; boil a quarter of an hour; remove from the fire; let cool; dry; put in the can; fill with boiling
water, lightly salted, and acidulated with lemon juice; close the can; leave two hours in a water bath.”

“Artichokes in Pieces: Prepare firm, sound, tender, freshly gathered artichokes; remove the outer leaves; trim the bottom; cut each one in four; remove the straw (florets), blanch in lightly salted water; drain; sprinkle each piece with lemon juice; half cook in a dressing the same as for hearts; close the cans; cook in a water bath for two hours.”

“Artichoke Purée: Remove the leaves from thirty-six artichokes; blanch; dip in cold water; remove the straw (florets); trim the bottoms so as to remove the hard parts; sprinkle with lemon juice to whiten them; cook in a dressing and let half cool; drain and pass through a tammy; fill into half-liter cans; close; cook an hour and a half in a water bath; the purée is completed with reduced veloute or bechamel.”

Rocques in 1906 indicated that the artichokes grown in the environs of Paris were preferable for canning purposes to those grown in the south of France, and were graded for size as follows: Maitres, petits maitres, moyens ailes, petits ailes, and mignons.

The brine or solution used in the cans was composed of water, 100 litres; salt, 2 kilos; and citric acid, 200 grams. The time for sterilization is given as 15 minutes at 108° C. (226° F.), or 45 minutes at 102° C. (215° F.).

Rolet in 1913 recommended a brine composed of 30 grams of salt and 1 gram of carbonate of soda per liter in lieu of citric acid, as used by others. He also gives a method of preparing artichokes a la Barigoule as follows:

“The outer coarse bracts are removed and those which remain cut back; they are put, point upward, in a casserole. The casserole is previously supplied with some spoonfuls of oil, carrots cut into small pieces, minced onions, the whole seasoned with salt and pepper, and the artichokes wet with oil. The casserole is covered, heated on a low fire, and the contents mixed from time to time. When the carrots and onions begin to brown, moisten with white wine which has been reduced one-half; add some cloves of garlic, spoonfuls of water, and finish the cooking in the cans sterilized in a water bath. Sterilize a half hour for half-liter cans in the autoclave, or from one and a half to two hours in the water bath.”

Madame Renée Raymond, who has written the most carefully prepared work upon home canning, that is likewise applicable to small factories, is explicit in her directions for the prevention of discoloration in the artichoke. She advises that all operations, such as cutting the scales to length, the removal of the scales from the base, and trimming the bottom, be done with the bud submerged in water; that the blanching and cooking operations be conducted without any delay between the steps, and that the jars be filled with artichokes and followed immediately with the brine. The blanching is to be done in copper or enamel, but never in iron vessels. By following this procedure the product will be bright in color and without any foreign flavor due to added substance.

Rousset in 1925, and Ray in 1926, give practically the same methods as the preceding for the canning of this vegetable. The blanching is done in weak brine containing some citric acid, and the brine used in the cans is also made to contain some citric acid (2 per cent or less). The process recommended is 110° C. (230° F.) for 15 minutes or one and one-half hours at boiling.
The Italian method of conserving the artichoke is described in a short paper of which the following is a translation:

"CANNED ARTICHOKEs AND ARTICHOKEs PRESERVED IN OIL

"One of the luxury products of radiant Italy that deserves to be better known by Americans is the small artichoke in oil.

"The artichoke, so popular in the south of Europe, to which region it is indigenous, is a savory vegetable that is easily digested. It is known botanically under the name of *Cynara scolymus* and belongs to the family of *Carduinae*, or in other words to the same family as the thistle, which the artichoke resembles but is considerably the larger.

"The edible part of the artichoke is the flower-cup, or the receptacle that carries the inflorescence of the plant, and is the fleshy base of the divisions of the calyx or the leaves that enclose the calyx. Artichoke bottoms are frequently used in the better hotels and restaurants.

"There are four or five varieties of cultivated artichokes, namely, the green artichoke, the red, the blue, the white, and the sweet or Italian, and these varieties differ in the color and size of the fruit.

"The green artichoke and the sweet or Italian are the best varieties, the first by reason of its notable size, flesheness, and tenderness, the second by its sweet taste, tenderness and delicacy.

"Artichokes are prepared for the table in many ways; they may be simply boiled, the leaves separated and eaten; the base is immersed in a prepared sauce, with olive oil, salt, and pepper, or it may be fried in oil with or without stuffing, the stuffing consisting of grated bread, eggs, and anchovies.

"The artichoke bottoms are used largely in the French and Italian kitchens for frying in the same way that mushrooms are used. Artichokes are also eaten raw, immersing the base of the leaves in a sauce prepared with olive oil, salt, and pepper.

"When the artichokes are in condition to be used on the table or to be canned, the outside leaves are removed if too hard, and the top and bottom made round, the top being cut back about two and a half centimeters (one and a quarter inches).

"The artichoke is a garden vegetable held in high esteem by the Roman people. The most popular method of preparing them in Rome is according to the Israelitish usage, frying them in oil, though it cannot be said that this is the most tempting way or contributes to the greatest pleasure at the table.

"Wine agrees with artichokes, probably due to the presence in the artichoke of a slight tannic principle similar to the tannic element in wine. Its taste harmonizes with wine, which is one of the reasons that artichoke gardens spread and become so popular in all the wine-producing countries.

"Artichokes are prepared for canning in the same way as other vegetable products. After having cleaned them, removed the hard outside leaves, and trimmed the bottom and top, they are sterilized at 110° C. for about an hour. The brine is lightly salted and contains from two to two and one-half per cent of bicarbonate of soda.

“Sometimes before boiling them they are held for two or three hours in water containing about 1 per cent of sulphurous acid, for the purpose of bleaching and extracting from them the bitter principles which are present to a greater extent in some varieties than in others. The artichokes so treated are rinsed well in fresh water to remove whatever traces of sulphurous acid may remain, and are afterwards heated and sterilized in the manner already described.

“In the preparation on a small scale to provide for domestic needs, the artichoke is first boiled about ten minutes in lightly acidulated water (with lemon juice) and then preserved in lightly salted water in the manner previously described, using as a container glass vessels, hermetically sealed, heating continuously in a double boiler.

“In industrial establishments the cleaning of the artichoke is done mechanically. The artichoke’s bottoms are prepared for preserving in tins or in glass containers in the identical way previously described.

“Artichokes are preserved in olive oil and are prepared for preservation in the oil in a different way from that just described. For such preparation only the small sweet Italian artichoke is selected, the bottoms not larger than a walnut kernel, as when preserved in this condition they are most tender and tasteful.

“After having cleaned them, they are boiled for five or six minutes in slightly salted water, for the purpose of eliminating some traces of the bitter principles that they naturally contain; then they are boiled for a quarter of an hour in good wine vinegar, to which is added some aromatic spices.

“Taken from the vinegar they are allowed to drain, then are placed in glass containers of different sizes, covered with the best olive oil in the same way as mushrooms are prepared in oil.

“Orbetello, a small city on the coast railway that goes from Pisa to Rome, not far from Civitavecchia, but to the north of the last city, is famous for artichokes in oil prepared in the manner described. They constitute, the Italians say, a true and delicious lunch, or an ideal side dish, and they are excellent prepared in salads.

“This special quality of artichoke is prepared only in the Roman country and neighborhood, and as in the case of other luxuries, seems to be too highly priced, yet they are not when one considers the great care necessary in their selection and preparation. Neither are they expensive if it be considered that they are served in small quantities and the contents of the glass are not necessarily consumed at the first opening, as they remain in good condition under oil until all are used. They stimulate the appetite, are sweet and tender, and predispose to the substantial enjoyment of the dishes that follow in the course of the dinner.”

The possibilities for canning artichokes in this country was first recognized by Jean Pacrette, of Paris, who acted as consultant in food technology in the nineties. His book, “The Art of Canning and Preserving as an Industry,” although published in this country, is in reality foreign, and some of the methods are not permissible in this country. That given for the artichoke belongs to this class, but is given here to make the history complete. It is as follows:
“Artichokes

“Artichokes should be preserved in the States as they are in Europe; they are a real delicacy and their cost in Louisiana or California is extremely low. They are seldom put up whole, as a quart can only hold one, when it can easily hold three or four if cut in quarters. Whole or quarters are treated in the same way.

“Blanching—Cut the artichokes in four, throwing them in cold water containing one ounce of sulphite of soda per ten gallons of water to prevent them from turning black. Blanch the artichokes in this same water, adding one-half ounce of sulphate of copper to each twelve gallons of water to fix the green. After two to four minutes boiling, throw in cold running water to cool off. The artichokes must only be put in the blanching bath when same is boiling.

“Brine—The blanching must not cook the artichokes; it would soften them too much, and the leaves would not hold to the bottom. As soon as cooled remove the fibrous seeds with a knife and trim the leaves with scissors, put in cans or jars and cover with brine. Water, 5 gallons; salt, 1 1/2 pounds; alum, 1 ounce.

“This brine must be made hot but used cold.

“Process—Pints, 12 minutes at 235° F.; quarts, 18 minutes, and half gallons, 25 minutes. Or four times as long in boiling water.

“Artichoke Bottoms

“The artichokes must be thoroughly blanched, but, by boiling in water, they are liable to break. This is avoided by placing them in water in a processing kettle, placing over them a heavy sheet of iron plate and cooking for three minutes at 220° F. Shave the bottoms evenly with a knife, take off all the leaves and seeds by hand and place the bottoms in white willow baskets and plunge them in a kettle containing a solution of bisulphite of soda.

“Bisulphite, 2 ounces; water, 6 gallons.

“Cook slowly for 16 minutes and cool off in several changes of cold water.

“Can in tins or jars. The bottoms being quite soft, it is customary to process in plain boiling water. One-half pints, 50 minutes; pints, 65 minutes; and quarts, 80 minutes.

“Avoid as much as possible leaving the artichokes in contact with iron, as this metal makes them turn black.”

Domestic Canning

Robert Hickmott, the pioneer asparagus packer on the West Coast, was the first commercial packer of the artichoke in this country. He began packing in a small way in 1912, following essentially the French methods. He packed whole and trimmed artichokes or artichoke hearts and used a tall can designed especially for the packing of whole or Melba style of peach. Others took up the work, but the demand has been very limited, as so few persons comparatively know about the vegetable. The pack in 1925 is estimated to have used about 600 tons of raw material, and there has been no substantial increase since that time. Most of the packing is done by two firms.
The packing of the artichoke presents little difficulty as far as keeping is concerned, but does require more than ordinary care to produce a product which has an attractive appearance.

It has been learned by experience that the best artichokes for canning are those which develop in the early part of the season, and this is particularly true for those intended to be used whole. The usual procedure is to get the early buds on the fresh market in order to take advantage of the higher price which usually prevails at that time, and to can when the market becomes fully stocked in the latter half of the season; that is, in March and April. The buds are best when selected full size, fleshy and tender, but with the bracts well drawn together. When the bud begins to loosen at the tip or open, then there is more or less tendency toward a brownish discoloration at the base of the bracts and around the bottom, a defect in appearance only, but objectionable in the trade. The same amount of discoloration or more in a fresh artichoke would go unnoticed or without criticism, but looked upon as a blemish when canned. The stems are cut back two inches or more as a rather long stem affords some protection against drying, too rapid change in the bracts, and also against discoloration of the heart. Drying and toughening does not take place nearly as rapidly as in asparagus, nevertheless, the buds should be gotten into the factory and worked upon promptly to keep the changes at the minimum. The fact that they appear so resistant and firm is an invitation to negligence in this respect.

The first operation is to thoroughly soak and wash the buds, as there is usually fine dust between the outer rows of bracts, which is difficult to dislodge without first loosening and then using strong sprays of water.

Artichokes are packed whole, trimmed as hearts, and as bottoms. Medium sized buds are preferred for packing whole, as after blanching four buds can be put in a No. 2½ can or two in a No. 2 can. This is the most desirable size for these two cans, as they will be well filled and the buds not mashed. About 20 per cent of the pack is put up in this way. A few large buds are packed two in a No. 2½ can or three in the extra tall No. 2 can, but the tendency is toward using the standard cans and to pack without waste space.

One of the difficulties in the packing of whole buds is that the leaves cling so close together that the air is trapped and water does not penetrate equally to all parts during the blanching, a matter which may account for some of the irregularities in discoloration. The same thing occurs when the brine is put on in the cans so that cans which are apparently full when sealed may show variations of as much as three-quarters of an inch in head-space after cooking. It should be comparatively easy to correct the difficulty in both cases by vacuumizing, and it is possible that if this were used as a preliminary step in blanching that would suffice.

The principal packing is with hearts and in this style there is considerable variation in the cutting and grading. In some the bracts are cut very short and in others they are left a half inch or more in length or suitable for different ways of serving them by chefs. The favorite size seems to be from 9 to 11 hearts for a No. 2 can, though the variation runs from 6 to 16 per can. About 70 per cent is put up in this style.

Artichoke bottoms are prepared from heads of all sizes and those which
are more mature than are desired for use in whole buds and hearts. All
the outer leaves and florets are removed, so that nothing remains except
the choice edible base. They constitute about 10 per cent of the pack. The
trimming of the hearts and bottoms is done with power machines which
must be hand fed. They are immediately plunged into water, or a brine
containing about a quarter of a per cent of citric acid, or the same acidity
of distilled vinegar, to prevent oxidation. There is less irregularity in the
discoloration about the base of the bracts and the bottom than with whole
artichokes and no irregularity in the fill of the can in short cut hearts and
bottoms.

Machines for trimming artichokes have been patented by G. D. Gardner,
San Jose, California, under No. 1,830,199, November 3, 1931, and H. A.
Vetch, San Jose, California, under No. 1,906,438, May 2, 1933.

The blanching is done in a 2 per cent brine to which from one-tenth to
three-tenths per cent of citric acid is added. The time required is longer
than that for most vegetables, being from 10 to 20 minutes. The French
custom is to blanch until half-cooked or from 15 to 25 minutes. The buds
are chilled and kept submerged in water and packed in cans promptly. If
the blanching be done in salt water, a two per cent brine is sufficient in the
can, but if the blanching be done in plain water, a three per cent brine is
preferred. If the blanch bath contains citric acid or vinegar, then no acid
is needed in the brine in the cans, otherwise from one-tenth to two-tenths
per cent citric acid is used in the brine for packing. The acid assists in pre¬
venting the dull leaden color usual to the product when this precaution is
not taken. It has been recognized as a part in the packing of this product
as well as that of some others, so that it is permissible. It gives a slight
acid taste, but as this delicacy is most often served with a mayonnaise dress¬
ing or other tart sauce, this is not an objection.

The sterilizing of the artichoke is easy, as free liquid surrounds the
heads, hearts, or bottoms, and conveys the heat promptly. The process
most used is 245° F. for 20 minutes for the No. 2½ can.

S. R. A. 291 (109). Declaration of Quantity of Contents of Canned
Artichokes.

The bureau is of the opinion that the quantity of the contents of canned artichokes
should be declared in terms of the net weight of the drained contents. An additional
statement of the number of artichokes in the can may be made if the canner so desires.

Bibliography

The Bibliography on this subject follows:

Appert, Nicolas. Le Livre de tous les menages, ou d’Art de Conserver, pendant plus¬


Lebault, Armand. La Table et le Repas. Paris. N. D.

Le Feuvre, Rene F. La Alcachofa. Santiago. 1906.

Asparagus belongs to the large genus Liliaceae, but is the only one which is cultivated for food. Its near relatives, the long-growing, finely-leaved vine, the ornamental basket varieties, and the smilax are favorites with all florists for decorative purposes. This pot-herb has been used and cultivated for so long and has become so widely distributed by man that it is difficult to determine its natural habitat. It is believed to be native to the coast of England and to the central portion of eastern Europe, especially to southern Poland and Russia, in which countries it grows wild on the marsh lands, and is eaten by stock the same as grass. It is also common in a wild state in Greece.

The Greeks were the first to use the plant, as far as known, which can be traced to about 600 B.C. They prized and were cultivating it at the time of their subjection by the Romans, who in turn immediately introduced it into Italy. Cato, a Roman, writing about 200 B.C., distinguished between wild and cultivated varieties, gave a description of the making of the beds and their cultivation similar in most respects to that followed in kitchen gardens at present. Pliny, another Roman, who wrote about 75 A.D., states that the plant was a favorite with his countrymen who recognized differences in the product, that grown near Ravenna being preferred because of its size and quality. The stalks were so large that often three weighed a pound, and it is noted that the same locality still maintains its reputation for the growing of the plant. Cultivation was extended along the Mediterranean, and thence carried into France and other parts of northern Europe as the Romans came in contact with the Gauls, Germans, and Britons, and introduced their table customs among them. Cultivation reached its highest stage of perfection in France. The older literature makes frequent mention of the excellent quality of that grown in Holland, and one or two of the best known varieties now in use originated in that country or from stock brought from there. It is not known when the plant was brought to this country, but it is believed to have been by early colonists and introduced at several points. It is mentioned in an English book as in use in New England in 1672.

Origin of the Term Asparagus

The origin of the term asparagus has been questioned but the weight of authority seems to be as follows: The present term is from the Latin, which in turn seems to have been derived from the Greek equivalent to asparagos,
APPERTIZING

and this again from the Persian equivalent to asparag, meaning a sprout. In this instance the term had a specific meaning of sprouts from roots as distinguished from the aerial parts of a plant.

In A New English Dictionary, by Murray, the more modern use of the term is traced in Medieval Latin as sparaquis, and sparagi; in old Italian as sparagi, and modern Italian as spargio; in German as spargen; modern French as esperage; in English of the 16th and 17th centuries as sperage, or sometimes sperach. He states:

"About 1600 the influence of the herbalists and horticulturist writers made asparagus familiar, and this is the apethic form. 'Spaargus at length displaced sperage, but was itself by popular etymology corrupted before 1650 to aspara-grass, sparrow-grass, which remained the polite name during the 18th century. Botanists still wrote asparagus, but according to Walker's Pronouncing Dictionary, 1791, 'Sparrow grass is so general that asparagus has an air of stiffness and pedantry.' During the present century (19th) asparagus has returned into literary and public use, leaving sparrow-grass to the illiterate; though 'grass' still occurs in cookery books."

If common usage be the guide for determining correct form, then "grass" also has a place, as it is the term most commonly used by those who cultivate the plant, handle it in the factories, and by the majority of those who market it. The modern German is spargel; Dutch, aspergie, and Spanish, esparrago.

The Plant

The edible asparagus plant is a fairly hardy perennial, cultivated in the temperate parts of Europe and the Americas, growing to a height of from three to six feet, the main stem being tough and fibrous, with numerous branches, but without true leaves. Instead of leaves there are innumerable small leaf-like branches or almost hair-like projections called clatodes. The leaves are scales, at the axils of which arise diminutive branches, which are green and function as leaves. The flowers are inconspicuous and form in the axils of the small branches. The fruit is a small dark red berry. The plant will grow under almost any conditions, but requires a well-drained, light, deep, rich, moist but not wet soil, to produce the thick fleshy succulent shoots suitable for eating. A characteristic of the plant is that it produces an extensive root growth with thick heavy crowns, which store up large quantities of food material to supply the new spring growth. By covering the crowns with a thick layer of light soil from ten to thirty spears are sent up, which average nearly an inch in diameter and eight inches in length. In exceptional cases three or four spears weigh a pound. A crown with the mass of fine roots attached taxes a team to loosen it from the soil.

Beginning of Cultivation

As already indicated, asparagus was cultivated by the Greeks and then by the Romans prior to the Christian era. From an early description of the methods used, it would seem that they had made more progress with this plant than with many others of much greater importance. In one account much stress is placed upon not having the manure or fertilizer in the bottom of the trench when starting a new bed, but to incorporate it abundantly in the soil. One peculiar practice, however, was to bury horns, especially those from the sheep, in the beds. These were supposed to exer-
cise some beneficial influence upon the crop. That practice persisted for
several centuries and is said to be followed still by some peasants in south-
ern Europe.

The custom gave rise to one of the classic experiments in agriculture,
that of demonstrating that the character of the final products of plant
growth are little affected by the nature of the plant food in the soil if the
essential ingredients be in sufficient quantity.

The French recognized the value of the plant at an early date and intro-
duced it into their gardens, and ever since they have given more attention
to its cultivation than has any other European country. During the few
weeks in the spring when available, it is the aristocrat among vegetables,
sought after by those in affluence, and purchased as a permissible indul-
gence by those of limited means. The thrifty cooks find ways by which a
very little is made to serve for a whole meal. The demand is such that the
plant is grown in all market gardens and in the majority of home gardens.
The plant was cultivated in England as far back as 1597, and cultivated in
forcing beds as early as 1670. A description of the husbandry as given in
Adam's Luxury and Eve's Cookery, published in 1744, may be accepted
as good English and European practice of two centuries ago, and is as
follows:

"Asparagus: This delicious Plant is propagated by Seed, which is
commonly sown in February or March in a Bed of good rich Earth; and
if your Soil is naturally very light, you may tread the Ground all over after
the Seed is sown, and then rake it, and it will by that means not be so sub-
ject to rake in Heaps, and consequently come up uneven but will come up
more regularly. Take care if it lies in your power, to have the Seed saved
from large Stalks, so may you reasonably expect the larger Grass. When
you sow it don't spare for Seed, and if it should happen to come up too
thick in some Places, thin it out to about four Inches apart, keeping it
clear from Weeds all the Summer; and in October or in November, if the
Weather continue mild, cut off the Haum and throw over the Bed a little
rotten Dung, which will preserve your Roots from Frost.

"In March following (For I would never plant Plants for a Piece of
Grass of above one Year's growth) your Asparagus should be planted out
for good, which you are thus to perform:

"First, we suppose that you have already prepared your Ground by
digging it a good Spit deep, mixing (and not burying) a good Quantity
of well-rotted Dung with it. If your Ground be a hot dry Soil, Ox-stall
Dung is the best; if cold wet Ground, then Horse-Dung is preferable, as
being of a warmer Nature; but, as I said before, let it be mixed amongst
the Earth in digging, and not buried in the bottom of the Trench, as is the
common Practice, for it will continually wear downwards. Your ground
being thus prepared, after having forked up your young Roots with a
Dung-fork, strain a Line across the Ground the Way that you intend the
Beds to be, and with a Spade or a Hoe draw Drills about six Inches deep,
into which place your Plants about a Foot apart, spreading the Roots so
that the Crown or Head may be about an Inch and a half below the Sur-
face; this done, throw in the Earth over them, level, and proceed to draw
another Drill or Trench a Foot from the last, repeating the same as before;
and observe, when you have planted four Drills, to leave Space of two
Foot and a half, eighteen Inches of which will be for an Alley for the Convenience of weeding, watering, cutting the Grass, etc., and the other Foot will be left six Inches to the first Bed and six to the second, for Earth to the two outside Rows, that they may not be injured by digging the Alleys in the Winter. In like manner proceed, till you have planted the Piece you intend; and when done, with your Line mark out your eighteen Inches of Alley, and with a Spade throw out the Earth about four Inches deep, spreading it over the Beds, and then you may sow a Crop of Onions upon them, with a few Radishes if you please, for they will soon be drawn off, and the raking of the Clods, etc., will pretty near fill the Alleys up again. The Onions when up must be thinned out, clearing them from the Root of the Asparagus; but if the Season should prove dry after the planting of your Asparagus, and your Ground also naturally dry, it will be proper to water it once a Week till it is up, after which it will do without; but if your Ground is wet, there will be no Occasion to water at all. You must constantly mind to keep the Ground clean from Weeds by hoeing of them down with a small Hand-hoe, at the same Time thinning out the Onions to about six Inches apart, doing it in dry weather, that the Weeds may wither. In October and November, when the Haum is wither'd, cut it down within an Inch of the Ground, and clean off the Weeds from the Beds into the Alleys, digging up the Alleys and throwing part of the Earth over the Beds, and with the rest bury the Weeds in the Alleys, leaving them about four Inches lower than the Beds in dry Ground, but in wet six or seven.

"In March, with a little flat-prong’d Fork dig over your Beds, being careful of the Roots in doing it, afterwards raking them smooth.

"The second Year after planting, some People cut some of the largest Stalks; but I would advise to stay three Years, their Heads will be much the larger, and the Roots will continue to produce larger Stalks for the succeeding Years.

"But there is another Method less tedious and troublesome than the former, tho’ not so frequently practised, and is in my Opinion preferable to the other, the Heads being commonly larger, and the Roots continuing longer; which takes as follows:

"Being provided with a Quantity of good Seed, and your Ground well digg’d and dung’d, with a small Hoe draw Drills, the same Distance from each other as before directed, and about an Inch deep, dropping your Seed in pretty thick and covering them; make the same Number of Drills as in the other Way, allowing the same Distance likewise for Alleys; then sow a Crop of Onions, raking the Ground very smooth. When the Asparagus is all up, thin it out, leaving the Root about a Foot apart, and thin out the Onions so as not to damage the Asparagus, and mind to keep the Ground entirely clear from Weeds, cutting down the Haum, digging the Alleys, earthing the Beds, etc., and if before you dig the Alleys, you always give the Beds a Covering of very rotten Dung about an Inch thick, and throw the Earth of the Alleys over the Dung, it will greatly improve your Asparagus. In three Years after sowing, provided your Ground is good and well managed, you can cut considerable good Grass from some of the largest Roots, and the fourth Year it will all be fit to cut.

"There is yet a third Method of raising of Asparagus remains to be
treated of, which is by planting of Roots of three, four, or five Years old, the longer the better, on Beds of Hot Dung made in the following Manner:

"Provide a quantity of fresh Stable-dung mix’d with Straw, throwing it on a Heap for a Week or more, turning it over once in the Time, and mixing a few Coal-Ashes amongst it; and by so doing, you will have a more moderate and lasting Heat, than if you made your Bed, as some do, with the Dung directly from the Stables, without any Ashes, etc. When you make your Bed let it be three Foot thick in Dung (if it is in the midst of Winter, but in the Spring two Foot and a half will be enough), beating it well together, as you make it, with your Dung Fork; and if your Ground be upon a dry Situation, you may make your Trench for the Dung 18 Inches deep, but if wet, make your Bed almost all above Ground. When your Bed is made according to the Length and Width of the Glass Frames you intend to cover it with, Earth it all over about half a Foot thick; this done, take up your Roots and begin at one End of the Bed, laying them as close as possible one to another with their Crowns uppermost, scattering as you go betwixt each Row a little Earth. When you have thus filled your Bed, twist a large Roll of Straw, and peg it fast down all round the Bed for the support of the Earth to the outside Roots. After your Bed has been made a little more than a Fortnight, if it heats kindly, you will find the Roots begin to stir a little, then you give them an earthing of two or three Inches of good rich Earth; and as soon as you observe the Buds begin to appear thro’ that Earth, give them another Earthing of two or three Inches more, which will be sufficient: And if your Bed is not over hot, you may put on the Frames; or you may put on the Frames at the first, only keeping the Glasses off whilst the Bed is hot, and putting them on if it should rain, snow, etc., to keep the Bed from being chilled by the Wet, giving a great deal of Air by tilting up the Glasses with a Stone, etc. And as soon as you find the Bed moderate, you may let the Glasses abide on constantly, observing to give a good deal of Air when the Weather is mild in the Day-time, covering the Glasses at Night with Mats, etc.

"These few Directions, if attended to, are better than a multitude of Words, and will I don’t question afford the ingenious Practitioner the Success he desires; but if you intend to continue forcing of your Asparagus till you have it in the common Ground, you must make a fresh Bed at least once a Month, that the new one may afford Asparagus fit to cut before the old one is worn out."

A hundred and twenty-five years later, the Treasury of Botany referred with much pride to the cultivation of the plant in England as follows:

"At Mortlake, Battersea, and other places near London, where the soil is suitable, Asparagus is extensively cultivated, and by skilful management is brought to a higher degree of perfection, perhaps, than in any other part of the world. The part of the plant which is used is about six or eight inches of the young shoot, which is considered fit for cutting when it has emerged two or three inches out of the ground, and has a firm compact, rounded point, of fine green color, slightly tinged with purple."

Asparagus has gained a reputation in this country somewhat like that in France, that it is a luxury to be desired by all who appreciate good and distinctive food. This view has stimulated large production for the fresh market, the shipment of hundreds of cars by express from one side of the
continent to the other, special packaging, and sales at prices in excess of those for other vegetables. It has had a similar effect in stimulating the canning of a large quantity when at its best to get attractiveness and quality.

Varieties Used for Canning

There are many varieties of asparagus, or perhaps it would be more nearly correct to say that it has been estimated that more than a hundred and fifty so-called varieties have been offered by seedsmen, but that of this number only about a half dozen have had sufficiently distinct characteristics or merit to persist. In France the outstanding variety is Argenteuil, which was originated about 1860 from seedlings from the Purple Dutch by an asparagus grower at Argenteuil, France. It produces large white stalks and the tip does not open at once or “flower,” but remains close and rounded until an inch or more above the ground. It is grown in this country, but is not so well adapted to the conditions here as some other varieties. Colossal, Conover’s Colossal or Van Sicklen’s Colossal was originated about 1882 on Long Island by Abraham Van Sicklen, a gardener, but introduced by S. B. Conover, a commission merchant of New York, and is grown extensively for the fresh market, but in only a limited way for canning. Palmetto, a variety of Southern origin, introduced by Peter Henderson, 1889, is a favorite for both the garden and for canning, as it has a sprout of good shape and finish and in addition a fairly high rust resistance. It is said that ninety per cent of the canned asparagus prior to 1925 was of this variety. During an investigation by Prof. J. B. Norton, of the United States Department of Agriculture, upon a means to overcome rust, two varieties were developed which are practically immune to this disease. These are the Martha and Mary Washington. In 1910, one seedling male plant called Washington was observed to be practically immune to rust, and was crossed with a Reading Giant female, producing the strain known as Martha Washington. Another cross of a Washington plant with another Giant plant from the Reading bed gave the Mary Washington strain, which likewise is practically immune to the disease. Both strains have excellent marketing qualities and are rapidly taking a place in market gardens and for canning.

According to Prof. W. W. Robbins, of the California Experiment Station, “Almost all asparagus varieties can be placed in two groups according to the color of the spears: (1) Varieties with light grass spears, of which Conover’s Colossal is most representative. Before they are exposed to the light the spears have a violet or reddish tip. (2) Varieties with dark green spears and a purplish overcoat. These varieties are purple tipped before they are exposed to the light.”

Packing Asparagus

It was natural that Appert should have selected this vegetable, which was so highly regarded, as among the first for canning. The small-mouthed bottles which were available to him precluded the packing of whole spears, and thus the product lacked much of its later attractiveness, but this defect was corrected when large-mouthed jars and tin cans came into vogue. The whole stalk is the form which is most desired, both abroad and in this country. From the beginning the French gave special attention to the develop-
ment of methods which would yield the best results in both flavor and appearance, so that it constitutes one of their most important canned foods.

The beginning of the packing in this country is clearly fixed, the credit for which belongs to William R. Hudson, of Hunter's Point, Long Island, a place within the incorporation of what is now Greater New York City. He packed 400 dozen No. 3 cans in 1864. The methods which he followed in cutting, trimming, and blanching were similar to those used at present, though the cooking process was different. Pressure kettles had not come into use, so the closed cans were first heated in boiling water for thirty minutes, then taken out, vented, resealed, and returned to the bath for an hour and a half. The results were satisfactory, the pack and that of the following years found a ready market. The square can was used in order to hold the stalks in place and prevent injuring them in handling.

Within a few years the land then in use became too valuable for growing asparagus for canning and new beds were planted in different places in New York and New Jersey. The high cost of producing the spears and later damage to the beds from rust were handicaps which kept production at a low point and dissuaded canners from engaging in that line.

Bonvallet Brothers began growing asparagus in Illinois in 1871, but did not attempt packing until 1897. They were unable to secure a sufficient quantity of raw material to be rated more than small local packers. These men seem to have been the only ones to have made a serious attempt to pack the vegetable in the central states prior to about 1927.

The development of the packing of asparagus in California may be justly credited to Robert Hickmott. It was he who recognized the very exceptional natural agricultural and climatic conditions for the development of the plant in the delta lands above San Francisco Bay. He began experimenting with growing the plant in 1881, and later in canning and had achieved marked success by 1890. Nature was unkind to him, however, and his large planting on Bouldin Island, the first of its kind, was carried away by flood, but others with more financial resources at their command were able to profit by his experience and carry on.

The growing of asparagus is confined to a comparatively small area along the Sacramento and San Joaquin Rivers before they discharge into the Bay. The region is low and flat, made up of silt brought down by the streams and the decomposed vegetation that has accumulated for centuries. The rivers are dyked on both sides to prevent overflow of this ground and drainage is accomplished by canals and pumps. A water level of two and a half to three feet below the surface is most advantageous, and can be maintained by diverting water to the canals or by pumping, as conditions demand.

Asparagus is not grown in small patches or in fields of a few acres, as done for the eastern fresh market, but in large tracts. It is said that a single cannery operates more than 4,000 acres, and in addition purchases the product of other ranches. These tracts are divided into units generally of 100, 160, or 200 acres, the latter being considered the best balanced for operating and also the most profitable. It requires from 40 to 50 men during the harvesting, with quarters, teams, tractors, and tools for a unit of this size. The help for the growing and harvesting is generally made up of Orientals, as they can stand the kind of work and hot sun better than native white persons.
The scale upon which the growing of the crop is conducted can best be appreciated from the reports of the California Department of Agriculture. In 1935 the total area under cultivation was 71,000 acres, of which 50,000 were for canning. In addition the shipment of fresh asparagus to market amounted to 1,355 carloads out of a total of 2,105 carloads for the entire country. In 1936 the loadings of fresh asparagus amounted to 2,176 cars. The quantity canned over a period of twenty years is shown in the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1916</td>
<td>990,740</td>
<td>1926</td>
<td>2,236,111</td>
</tr>
<tr>
<td>1917</td>
<td>965,780</td>
<td>1927</td>
<td>2,189,570</td>
</tr>
<tr>
<td>1918</td>
<td>902,236</td>
<td>1928</td>
<td>2,237,950</td>
</tr>
<tr>
<td>1919</td>
<td>1,031,269</td>
<td>1929</td>
<td>2,672,637</td>
</tr>
<tr>
<td>1920</td>
<td>1,024,813</td>
<td>1930</td>
<td>2,663,191</td>
</tr>
<tr>
<td>1921</td>
<td>887,030</td>
<td>1931</td>
<td>1,747,499</td>
</tr>
<tr>
<td>1922</td>
<td>1,239,839</td>
<td>1932</td>
<td>1,313,231</td>
</tr>
<tr>
<td>1923</td>
<td>1,519,756</td>
<td>1933</td>
<td>2,134,942</td>
</tr>
<tr>
<td>1924</td>
<td>1,792,769</td>
<td>1934</td>
<td>1,914,208</td>
</tr>
<tr>
<td>1925</td>
<td>1,744,999</td>
<td>1935</td>
<td>2,238,400</td>
</tr>
</tbody>
</table>

The annual pack in all other states prior to 1930 amounted to less than 20,000 cases, or about one per cent of the total, but since that time has mounted to 275,000 cases.

Asparagus is inherently an expensive crop to produce, owing to the great amount of hand labor required, the high cost of land which it is necessary to use, the time required to bring the field into production, and to the fact that the land, when once planted, cannot be changed to another crop for several years. The land is made clean and thoroughly cultivated as a preliminary step. The seed is first grown in nursery plots in May and kept well tended until the end of the season, when the plants are taken up and stored until after the rains in February or March. They are then set in the fields, in rows about eleven feet apart and a foot and a half apart in the row; the distance between the rows has been gradually increased from eight feet to facilitate working with tractors and to permit machine ridging. The rows are laid out in the same direction as the prevailing wind, usually from southwest to northeast, so that one plant will help to sustain another and not be bent over and thus interfere with cultivation between the rows. No cutting is done the first two years, and only a fourth of a crop is expected the third year, and no full crop until the fifth year. The life of a field may be expected to continue from twelve to twenty years, though the crop usually decreases after the tenth year. Level cultivation is followed at first, but ridges are thrown up as soon as the root development has reached the point where good spears are produced. The ridges are made with special disking machines working in pairs to throw the earth into the proper shape. A finished ridge is about 18 inches wide at the top, 30 inches at the bottom and 12 inches high. The first ridges made in the spring are not full height, but are kept at about four inches to stimulate early growth, and also that the spears may grow to a height of three or four inches above ground to produce the green asparagus for the fresh market, as that style is preferred in many cities. The ridges are brought to full height as soon as the harvesting for canning purposes is begun. The high ridge produces a completely blanched stalk, as color is not manifest until the tip is acted upon by sunlight. Many persons familiar with the green asparagus upon
the market believe the whiteness in the canned product to be due to the use of some bleaching agent in the factory, but, as indicated, it is due to cultivation. The earth is kept cultivated so as not to form a crust, which would cause the spear to become crooked when breaking through, and to arrest any growth of weeds. The fields are bare until the end of June.

The yield per acre is based upon the trimmed boxes, which average 50 pounds. The yield per acre the third year is given as about 1,400 pounds, the fourth year as 2,800 pounds, and the fifth year from 5,000 to 6,000 pounds or more and continues at that rate thereafter. An exceptional yield is 8,000 pounds. When the product is sold to the factory by a grower, it brings on an average $70.00 per ton.

The inside dimensions of the lug box are 22½ inches long, 14 inches wide, and 8¾ inches deep. The asparagus is layered with the butts to the side and the tips toward the center. Cleats are attached at the top on each end to permit stacking without the bottom of one box touching the spears in that below, and to provide ventilation.

Harvesting

The harvesting season for asparagus is from the latter part of February to the first of July, but the quantity collected during the first four or five weeks is so small that it is absorbed by the fresh market, and at prices in excess of that which is profitable to put in cans. The actual canning period covers from 90 to 110 days, or practically three times as long as in the East.

The work of harvesting is done by men provided with a knife fashioned in the form of a long-handled chisel. The spear is seized by the tip between the thumb and fingers of one hand, and the knife inserted in the ground a few inches from the stalk and directed at such an angle that it will cut the spear about eight inches below the surface of the ground and at the same time not injure the crown. Several different kinds of knives have been devised, and some patented, but none has taken the place of the chisel for cutting for the cannery. Two cutters have been made with handles of sufficient length to make it unnecessary to stoop when cutting, and as an accessory, a finger is placed on the staff to seize the spear when it is being cut. These devices are patented under Nos. 986,773, issued March 14, 1911, and 1,137,777, issued May 4, 1915, but are said to be less rapid in operation than the hand. The matter of “spotting” the spear just as it cracks the surface and cutting it at the proper depth are details which can be acquired only by experience. A man collects from two rows at a time, and when he gets a handful of spears he places them on top of one of the rows. If the cutting be light, he may use a basket or tray with a handle and carry the spears until the basket is full or to the end of the row. A good harvester gathers the crop from ten acres in a day when the yield averages a box of fifty pounds per acre, and receives from 40 to 45 cents per box. It takes an average of 112 to 125 men to harvest a thousand boxes per day. It is necessary that the field be gone over daily during the canning season, as an all-white product is dependent upon cutting before the tips are exposed to sunlight. If several cutters are working, it is customary for them to pair in placing the spears on the rows, the cutter in one pair placing his spears on the right while the one working with him deposits his on the left, making it possible to drive between alternate rows in picking it up.
After the cutters have passed and left their bunches of spears, another worker follows with a sled or low-wheeled truck and gathers them, cording them in a box to take them to some convenient point for preliminary washing and trimming to a standard length prior to hauling to the factory.

Theoretically the spears should be collected soon after cutting, but practically that ideal is not attained, or at least not in a great many cases. Not infrequently the collecting is made only once, twice, or three times during a day, with the result that probably more losses occur from this delay than from any other single operation in packing. The most valuable product is clear white and the average yield is only about 30 per cent. The effect of sunlight on the freshly cut spear is to cause photosynthesis, the development of chlorophyll, the green coloring matter. An exposure of two hours is sufficient to produce an appreciable effect, and for more than three hours to materially increase the percentage of stalks which must be rated as green after blanching, though they may appear white before that operation. William De Back states that the percentage of white spears on cloudy days is always higher than on bright, clear days; that on the former it may occasionally reach 60 per cent, and frequently 45 per cent, whereas on the latter it is generally less than 35 per cent. It is therefore easy to understand that leaving the spears in the field gives an opportunity for developing too much color to be classified as strictly white and not enough to be typically green, aside from any effect of soil stain and drying. It also indicates that in washing the spears should be handled under a shed and be covered while in transportation or held at the factory.

Eastern asparagus on the fresh market is generally green and in many cities there is a distinct preference for it. In order that the canned product may more closely approach that type, the ridges are not made to cover the roots more than about four or five inches and the spears allowed to attain a height of three inches or more before cutting. This gives a much deeper green and a more flowering head, directly the opposite from what has been sought. About one-third of the pack is now rated as green.

**Field Trimming and Washing**

For a long time the general custom was to take the spears from the sled or truck and cord them in a frame having a solid wooden back. The frame was from six to eight feet long and two feet high, with a depth of seven inches. The bottom and ends of the frame were fixed to the back, but the top member made adjustable so as to be brought into contact with the asparagus. The tips of the spears touch the back and the top is adjusted snug against the stalks to hold them in position. A large knife or a sickle from a mowing machine was used to trim the spears to an even length by drawing it across the projecting ends on a level with the outer edge of the frame. The loss from this operation amounted to from 16 to 20 per cent. A special frame for the purpose was developed and patented under No. 1,034,118 by M. Jongenteel, Oakley, California, July 30, 1912.

The spears were next dumped into a tank of water and agitated by hand or by means of a stream of water from a hose to loosen grit or dirt. Soil allowed to dry on the spears causes stains that penetrate below the surface and can be removed only by peeling, hence the advantage of promptness and thoroughness in this work. The spears were collected and again arranged with the tips in one direction and placed in lug boxes, the tips being
directed toward the center for their protection. In some places the washing was done first, then the asparagus placed in the frame and trimmed to length, after which it was packed directly into the lug box. This virtually saved one operation. The method is still in use though in 1927 a washing machine was developed, consisting of a tank with two wire belts, one to carry the spears and another above to hold them in place and a dozen or more sprays so arranged as to direct the water on every part of the spear. A pressure of 40 pounds or more is used, thus insuring a thorough washing.

The asparagus is placed on the conveyor with the tips all in one direction so that a revolving cutter trims all stalks to the correct length, and it is then picked off the discharge end and boxed. Three men are required to feed the machine and two to remove the trimmed spears, the five being able to handle a thousand boxes per day.

While the primary object, better washing, has been attained, thus lessening the percentage of lower grade materials, a secondary effect has been to get the raw material to the factory about two hours earlier in the day and thereby cut down the carry-over.

One effect of washing is to cool the asparagus, an important step during warm weather, the advantage of which is not generally appreciated. The cooler a vegetable can be kept, the less are the chances for deterioration prior to preparation. The separate stalks can be cooled to a lower temperature by a few minutes submersion in cold water than can be accomplished during a much longer period of sprinkling or spraying with a hose when packed close together in a box. Dumping the asparagus in a tank and hurriedly taking it out may only cool the surface a trifle and thus produce a minimum effect, whereas a much better result might require only a few minutes. The water should be clean and cool, and if this cannot be procured at the field, then the asparagus should be rushed to the factory where such facilities are available. This operation is of so much importance in its effects upon the volume of bacterial infection and on subsequent factory operations that much attention can well be given to the character of the water used and the thoroughness of the work. It should be neither perfunctory nor just careless routine.

The practice of trimming in the field was started when it was the custom to ship a considerable part of the crop to San Francisco or Oakland to be canned. It facilitated packing two rows in the lug box, reduced the freight on shipments, and provided a more nearly uniform basis upon which to make payment to the grower. The custom has persisted though the packing conditions have changed. It is more logical to leave the stalks as long as possible, as the extra length affords some protection against deterioration. Cutting in the factory is necessary to make either full length stalks or tips, and it can be done as well from the field-cut material as the trimmed and thus save one handling. It means the use of more boxes from the field, but the compensation would be met by a higher percentage of the highest grade.

Field work generally starts by 5:30 o'clock in the morning and stops at 2:30 o'clock in the afternoon but the factory does not ordinarily start until about 11 A. M. and must run until all the material brought in is packed. By eliminating trimming in the fields and washing that first gathered, an earlier factory start might be made. The factory was moved from the city to the vicinity of the ranch in order to improve quality by saving a day
between the harvesting and the packing, but a corresponding improvement to save a few hours on the ranch has been limited to handling in speed trucks instead of wagons.

According to the most approved procedure the boxed asparagus is taken to the factory as promptly as possible, as the succulent spear is in that stage of growth when the tissues are tender and unstable so that deterioration occurs quickly. It is probably the most sensitive of all the vegetables and, therefore, the greater the necessity for rapid action. Exposure to the sun, to drying, to heat, or other influences tend to reduce quality. Asparagus, such as found in the fresh vegetable market, is generally from two to seven days old, and would not be acceptable for canning purposes where a high grade is demanded. There is not only an increase in fibrous tissue on standing but also a development of a bitter principle. Probably the majority of persons who depend upon the product from the fresh market are accustomed to this and do not recognize it as foreign or objectionable. These changes will be discussed in greater detail in a succeeding paragraph.

The factory capacity and operations are generally based upon the principle of packing all the asparagus that is cut and delivered the same day. If this be impossible in a rush period, then the carry-over is thoroughly drenched at intervals with cold water to keep it as fresh as possible, and if the weather be warm, to prevent heating. This minimizes waste and retards the tendency toward fermentation. An even better practice is to grade out the choice material and pack it while in prime condition and sacrifice the very small and less desirable part. Experiments indicate that it is necessary to have a temperature at 40° F. or below to keep asparagus without, or with very little change.

**Sorting for Size**

The first operation in the factory is to sort the spears for size. Formerly some separation was also made for color, but now this is done after blanching on the packing table. During this sorting any stalks which show loose or open heads, called flowers, and those which are crooked, are culled out.

Separation for size is based upon the diameter. The largest, known as Giant, must be more than 1 inch in diameter, and varies from 8 to 12 stalks to the No. 2\(\frac{1}{2}\) square can; Colossal, from 12/16 to 1 inch in diameter, and from 13 to 16 stalks per can; Mammoth, from 9/16 to 12/16 in diameter and from 17 to 24 stalks per can; Large, from 7/16 to 9/16 inches in diameter and 25 to 34 stalks per can; Medium, from 6/16 to 7/16 inches in diameter and from 35 to 44 stalks per can; Small, from \(\frac{3}{4}\) to 6/16 inches in diameter and 45 to 60 stalks per can; and Tiny, less than \(\frac{3}{4}\) inch in diameter and more than 60 stalks per can.

The sorting is done directly from the lug boxes into the cutting frames which are arranged on shelves above the table. The work of sorting has been largely by the eye, though checks are provided in the way of a board with holes made for the different sizes or notches cut out to the widths corresponding to the diameters already given. It is the kind of task that is confusing to the eye and after a time differences of only an eighth of an inch are not easily discernible. The work is assigned to the employees who show special aptitude for the job. A good grader will sort from three to six boxes (150 to 300 pounds) per hour, and at present is paid at the rate of 11 cents per box.
Machine grading was first tried in 1904 and since then four distinct types of machines have been developed. The Corbill grader was the first and was in reality a modification of a string-bean grader. A series of parallel rollers, operating in pairs, the rollers turning away from each other so that the spears too large to pass between, served to make the separation. The Tiny grade is taken out first and then each next larger as the spears pass over the successive rollers. This grader was not patented.

The next grader is covered by patents Nos. 1,257,719, issued February 26, 1918; 1,282,250, October 22, 1918, and 1,333,858, issued March 16, 1920, is for a machine for cutting the asparagus to a predetermined length and grading it for size. Patent No. 1,299,198 is for a feeding attachment for the grader. These patents were issued to D. Low and A. R. Thompson, San Jose, California. The spears are worked crosswise on a belt so that the tips touch a guide and the butts are trimmed uniformly with respect to the top. The cut spears are discharged upon a roller grader of the type that diminishes at intervals and a carrier attached to a belt that acts to advance the spear until it will pass between the rolls.

The third machine is covered by patent No. 1,578,598, issued to Wm. De Back, Hayward, California, in which the principle of the roller fruit grader is used. The spears are carried between rollers that gradually separate as they move forward, and are dropped between when the proper spacing has been reached. The spears are cut to can length before they are discharged into the grader boxes. The capacity is from 18 to 22 boxes per hour for two operators. One of the advantages of the mechanical grader is that it does not become fatigued or lose accuracy after continuous work.

The fourth or latest grader, invented by L. D. Stoppel, Isleton, California, is a modification of the rubber tube grader built after the plan of the spreading rope grader. Pairs of rubber tubes take the place of ropes, and the spears ride between and fall through into different compartments as the tubes diverge. It is a simple machine.

The percentage of asparagus of the different sizes are subject to rather wide variations. The figures obtained from one of the large packers represent his pack for the year 1922.

<table>
<thead>
<tr>
<th>Grade</th>
<th>White</th>
<th>Green</th>
<th>1922 Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent</td>
<td>Per cent</td>
<td>Crop</td>
</tr>
<tr>
<td>Giant</td>
<td>.5</td>
<td>.5</td>
<td>1</td>
</tr>
<tr>
<td>Colossal</td>
<td>1.5</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>Mammoth</td>
<td>7</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Large</td>
<td>8</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>Medium</td>
<td>7</td>
<td>11</td>
<td>35</td>
</tr>
<tr>
<td>Small</td>
<td>4</td>
<td>8.5</td>
<td>15</td>
</tr>
<tr>
<td>Tiny</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ungraded</td>
<td></td>
<td>28.5</td>
<td>3</td>
</tr>
</tbody>
</table>

Cutting to Length

The cutting frames are generally made of wood, six inches wide, four and one-half high, and five and one-half inches deep, inside measurements. The stalks are laid in with the tips touching the back. If the stalks are intended for the regular No. 2 1/2 square can, they are cut across at the end of the frame; if intended for the No. 1 tall, or the No. 2 round can, they are cut at the four-inch slit in the sides, or if intended for tips, they are
cut at the three-inch slit. Formerly all the cutting was done with a long-bladed knife like a large butcher knife, but this has been supplanted in part by the use of a large revolving disk. The cutting frames are set on a belt that carries them past the revolving cutter at the proper point for cutting. The wastage on butts amounts to 20 per cent for the regular No. 2½ square cans, 33 per cent for the No. 1 and No. 2 round cans, and 50 per cent for tips. Nearly all the butt is a direct loss, as only a small part is used as a second cut for soup stock. The usual disposition of the butts is to float them into the river or bay.

The tip was developed as a product to utilize the stalks which had been cut too short, crooked stalks, and material which had been held over until the cut end developed too much fiber or bitterness to be used for the regular packing. It proved to be a popular article and instead of being a means to utilize a waste, it has developed into a distinct pack with a standard grading. The grades for the square can are as follows: Mammoth, 21 to 30 spears; Large, 31 to 40 spears; Medium, 41 to 60 spears; Small, 61 to 80 spears; and Tiny, from 80 to 100 spears. For the round picnic can: Colossal, 6 to 10; Mammoth, 12 to 16; Large, 17 to 22; Medium, 23 to 30; Small, 31 to 45 spears.

The first evidence of toughness and bitterness is manifest in or under the skin, especially at the butt, stains from soil show on any part of the surface, coarse scales sometimes occur and are objectionable, all of which make it necessary to brush, scrape, or peel some asparagus. This is limited as much as possible, as these operations are time consuming and labor is generally scarce where the factories are located. Peeling originally indicated an especially well-prepared product, but that is not the implication now, but rather to make acceptable what would otherwise be considered as defective. The loss in peeling varies from 20 to 30 per cent. The French have developed a machine for brushing the spears. It consists of two small revolving brushes, set fairly close together, made to revolve at a high speed like a buffer wheel. It is said to do efficient and rapid work but as far as known, none has been brought to this country.

It must be apparent at this point, even to the inexperienced, that with six grades for size on the regular cutting, five on tips, three on peeled stock, others for round cans, and still another for soup stock, that it requires extraordinary care to keep the cuttings separate and follow them through the blanching and filling to secure correct markings. A separation of white and green spears on the filling table adds a further complication. In no other product is there an equal number of grades. This part of the work has been carried to excess, but packers prefer to follow the accepted course rather than attempt something simpler.

**Blanching**

Each size of the trimmed and graded spears is kept separate and dropped into bamboo baskets for blanching. These baskets, a little larger and deeper than the standard bushel basket, are a Chinese introduction, and have proven better adapted for the purpose than anything else tried. Owing to the difference in size of the spears and their condition, each basket has to be treated as a separate lot, and not as a unit in a continuous process.

The half-filled baskets are set into a tank of boiling water until the stalks are pliable and will not break, though not allowed to become limp or flabby.
The one in charge of the work stirs the stalks gently to insure evenness in heating and tests the cook by bending a few stalks. The time required in this bath will vary from two to five minutes, the average being about three minutes.

The French use a different method of blanching. When the spears are taken out of the cutting box, they are set upright in a wire basket and kept in that condition by means of a frame. The basket is first suspended only two inches in boiling water, and this is continued for from one and one-half to two minutes, then the basket is lowered two inches more for a like period, and then completely submerged for one minute. The object is to give the greater cooking to the butt where it is most needed. Owing to the fact that the spears are touching each other and the boiling water does not have complete freedom of movement, the time required is a little longer than used here. They claim to get a better product for their pains. As far as known, that practice has been followed by but one firm in this country.

The blanching tanks are simple, made of planks, about two feet deep, five feet wide, and six or eight feet long, depending upon the number of baskets which it is desired to handle. Two baskets can be handled for each two feet in length. Crosses are provided in the bottom for distributing the steam.

The blanched asparagus is dropped immediately into cold water to arrest the softening process and to restore some of the crispness. It is then distributed to the canning tables.

**Filling the Cans**

Canning tables have been designed especially for handling this product. The distinctive features are the size and shape of the sinks or bins. The sink is wider from front to back than the fruit canning tables, and the front part is only one and a half inches deep, while the back is about six inches deep. The object is to expose to view as many spears as possible, so that those doing the filling can pick for uniformity of size and color to the best advantage. The blanching has the effect of bringing out the green color, and also to cause loose tips to show flowers, and these can be picked over more quickly when all are exposed. The final grading is done at this point, so that a good spread aids in making the selection.

The spears are collected with the tips in one direction and filled into the cans with the tip up. The can is filled until there is no free movement between the stalks. In some factories the stalks are laid on a scale having curved arms and the fill is made by weight. It is said that this results in greater uniformity and expedites the work.

An inspector draws cans from each packer at irregular intervals in order to detect poor work and to count the number of spears to be certain that the grading is being done correctly.

The work on the canning table is simplified to a considerable extent by using certain bins for certain sizes. Where so much is dependent upon the eye, the best results are obtained within a narrow range. A further advantage is that there is less danger of confusion in marking grades.

An operator fills from two to three cases per hour, depending upon the size of the stalks. Medium, Small and Tiny spears take the most time, and in selling bring the lowest price.
The State Industrial Welfare Commission fixes a minimum wage for women, and this becomes a basis for establishing rates for piecework which for filling asparagus practically amounts to the following: for No. 2½ square can, Giant, Colossal, and Mammoth, 6.5 cents per dozen; Large, 7 cents; Medium, 8 cents; Small, 9 cents; and ungraded, 5 cents. For the No. 1 square can for tips: Mammoth and Large, 7 cents; Small, 10 cents; Tiny, 12 cents, and ungraded, 5 cents.

In the making of tips, for which there is so much demand, the loss on trimmed stalks is 50 per cent or more, nearly all of which is equal in quality to that which is canned. In order to conserve some of this material, it has been packed as second tips for soup stock and for certain restaurant trade. These cuttings are filled into gallon cans without any attempt at arrangement. The finer butts have also been cut into uniform lengths of one-half inch for soup stock, but thus far the market has been very limited. Patent No. 1,512,377, issued October 21, 1924, to L. D. Stoppel, Isleton, California, is for a device for cutting these second tips and butts into slices or dice. The material is fed upon a belt and guide arms cause it to run lengthwise, first under two vertical disks which cut the pieces lengthwise, removing the sides, then against two horizontal disks which take off an upper and lower slice, leaving a central square portion the length of the piece.

Exhausting

The cans are filled with two and one-half or three per cent brine at a temperature of about 180° F. The air or gases in the tissues are pretty thoroughly evacuated in the blanching so that the main object is to get a moderate and uniform heat throughout the contents. This is done more effectively by giving more time at 200° F., or below, than at a higher temperature for a shorter period. A quick high heat is productive of collapsed cans. A poor exhaust favors a high content of salts of tin in the tissues after the pack has stood for several months. The factory practice varies from 9 to 12 minutes at 200° F. or below, and from 4 to 6 minutes at 210° F.

Closing the Cans

The closing of square cans requires a special machine which squeezes a closure between the cover and the body instead of rolling a double seam as done in the round can. The body and cover have the edges formed nearly the same as for the round can and the end provided with a paper gasket. The hooking of the two parts together is accomplished by a series of three squeezes between dies which turn the edges over in successive steps until there is a hermetic closure. This closure represents the most important mechanical development connected with asparagus canning.

From the beginning, it was recognized that a part of the value of the asparagus was in its appearance: the spears must be whole, of the same length, and arranged vertically. To prevent breaking the tips or fraying the body made it necessary that there be no movement of the product in the can during transportation or handling. The square can most nearly solved the container problem, but to fill it through a hole in the end or on the side near the end was difficult and required time. Only one or two spears could be inserted at a time, and later inspection was impractical. The open top can was hailed as the important step in the industry, but its closure
was limited to round and oval cans. The usual type of machine could not be remodeled to close the square type of can, but the difficulty was overcome by Jas. A. Gray in the manner indicated. His first machine was operated and patented as No. 1,010,617, December 5, 1911, and was so successful that it was immediately adopted by all canners, and by 1916 had displaced all solder cap cans.

It seems to have been taken for granted that the regular round can could not be used and a modification was proposed to stamp oval panels, usually five, extending from near the top to near the bottom, thus weakening the body along the stamp lines, so that when a vacuum was formed on cooling after the usual process, the panels would be drawn and make some pressure upon the stalks. Patents Nos. 1,083,311 and 1,159,989 were issued in 1914 and 1915 to G. W. Weber for such cans. Devices were also proposed to be used inside of round cans or glass jars to lessen the movement due to ordinary handling but these were not found advantageous. However, since 1933, there has been an increasing pack in regular round cans using the regular No. 2½ and smaller sizes. These have been handled through a continuous pressure cooker with a non-agitating reel, the product showing no detrimental effect from the method of packing but presents an improved color due to the shortening of the cooking.

Cooking

The cooking of asparagus in commercial canning is always done in the retort. It should be done as lightly as possible and still be sufficient to insure sterilization, as asparagus is particularly sensitive to heat. That cooked at or below 226° F. has a different and more pleasing flavor than that cooked around 232° F. Above 235° it takes on a distinctly cooked flavor which increases with the rise of temperature and becomes objectionable above 240° F. or at that temperature if the time be prolonged. Formerly, the practice was to cook No. 23 square cans at 230° to 232° F. for from 25 to 28 minutes for strictly fresh material, and for 35 minutes for that which had stood for a day or more. The means for cooling at that time were not as nearly perfected as at present, so that the real heating period may have varied somewhat from the figures indicated. This gave a product which was bright and glistening with sufficient turgidity in the spears to hold their form when picked up by the butt end. The flavor was especially good. The margin of safety, however, was not large and if the work did not proceed rapidly in the factory, held-over stock be used, or delays occurred for any reason, flat sours might result. Later experience has shown, too, that food poisoning is a possibility. About 1910, a change was made by increasing the temperature to 240° F. and shortening the time to from 12 to 22 minutes, depending upon the size of the spears and their condition. This temperature was gradually adopted by all the canners, but the time fixed between 18 and 22 minutes. The introduction of cooling under pressure in 1912 virtually had the effect of cutting the time by two or three minutes, or possibly more in some cases, so that it is difficult to make comparisons with present processes. The adoption of the higher temperature was followed by a decrease in the number of flat sours. One result is apparent, that the spears take on a yellowish tinge, have a dead appearance, with more or less softening, and more cooked flavor. These characteristics become intensified as the time is prolonged.
The present processes in California are fixed by the State Board of Health and are as follows: No. 2½ square cans or smaller, 240° F. for 20 minutes or 248° for 12 minutes; green asparagus, 240° for 23 minutes or 248° for 13 minutes. If sealed under mechanical vacuum, 240° for 25 minutes or 248° for 13 minutes. Soup cuts, No. 2½ can or less, 240° for 25 minutes or 248° for 13 minutes; 5 oz. can to drain not more than 0.25 ounces; No. 1, 7.75; No. 1 Tall, 11.75; No. 2, 14.25; and No. 2½ round, 21 ounces; No. 10 cans to receive 240° for 35 minutes or 248° for 15 minutes and contents not to exceed 75 ounces drained weight. Glass, 20 ounce jars at 240° for 20 minutes.

The French make use of two different cooks, one at 240° F. for 15 minutes for liter cans (No. 2½ square) or 218° F. for 50 minutes.

The Germans process at 240° F. for 10 minutes, allowing 6 minutes additional for bringing up the temperature in the retort and a like period for dropping it.

The use of glass in the commercial packing of asparagus is almost nil, amounting to a few jars for display purposes or as samples. New square jars have been introduced and with the use of auxiliary pressure in cooking and cooling, the work is simple. A peculiar property of glass-packed asparagus is that the flavor differs from that in tin. To most persons it seems flat. This is corrected by using a plain tin cap on the jar or placing a piece of metal between the stalks.

Asparagus was the first vegetable to be systematically cooled under pressure, though the method had been in use in meat packing since 1879, or for more than thirty years previous to its introduction in this line. It had been used also in a very limited way on gallon cans of peas and corn. The square can, because of its shape, becomes badly distorted, oftentimes opening the seams, after the steam pressure is shut off if the retort be opened at once. The higher the temperature used in processing, the greater is the internal pressure in the can and therefore to prevent damage and expedite cooling, compressed air or water under pressure is introduced into the retort to compensate for the internal can pressure and thus keep it normal. Water cooling follows without danger of causing a vacuum from chilling the vapor, and the whole operation conducted with precision within a definite time, whereas gross variations occur where such control is not used. A record of the time and temperature of cooking is required for each batch, and this is probably the greater factor in securing sterilization rather than the heavier cook since the fallible human element is eliminated. As a final step, batch marks are required on each lot, so that cans may be identified at any time or place.

Asparagus in round cans is now cooked in a continuous cooker without agitation nor damage to the spear.

Asparagus is not particularly active toward tin so that plain cans are used. The metal does have a slight effect upon flavor and in this case it is considered favorable. It also produces some bleaching as it is found that a product which is distinctly yellowish shortly after packing becomes lighter after a few months.

Label Weights

( Sp. Gr. 1.03) : No. 1 Square (300x308x308) 1 lb.; No. 2½ Square (300x308x604), 1 lb. 15 ozs.; 8Z Short, 7½ ozs.; 8Z Tall, 8¼ ozs.;
Picnic, No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 7 ozs.

Tips: The same weights.

Soup cuts (Sp. Gr. 1.01): 8Z Short, 7½ ozs.; 8Z Tall, 8 ozs.; Picnic, No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 15½ ozs.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs.; No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 5 ozs.

The standard packing for the No. 2½ square can is two dozen to the case, 16½ by 15¾ by 10 inches, and a gross weight of 65 pounds. No. 1 square cans for tips, two dozen to the case, 13¾ by 11¾ by 8 inches and a gross weight of 37 pounds.

Deterioration in Asparagus

Surprisingly little experimental work has been done upon the canning of asparagus when one considers the importance which it has attained. The writer reported a few experiments in Bulletin No. 196 of the Bureau of Chemistry, the object being to determine the effect of standing upon the quality of the canned product. The following excerpt shows the results:

"One lot was packed within 3 hours after cutting, a second lot within 24 hours, a third within 48 hours, a fourth within 72 hours, and a fifth within 96 hours. Each lot consisted of two parts of about 20 cans each, one part being filled with long or full-length stalks, and the other with tips.

"The lot put up immediately on arriving at the factory was perfectly tender from the tip to the base in every stalk. It had a bright, clean, crisp appearance.

"The lot put up within 24 hours lacked some of the clean luster characteristic of the fresh, the tips were all tender and gave no evidence of unnatural flavor. The full length spears were excellent at the tip, but more than 30 per cent were a little fibrous at the butt and had the beginning of a bitter flavor.

"The lot held 48 hours showed more dulling in color, the beginning of a yellow cast, and a little wrinkling of the stalks, as though they were shrinking. The tips were good, with only the beginning of toughening at the base and some bitter taste. In the full stalks the base was decidedly fibrous for nearly one-half the length, and had a decidedly bitter taste at the butt, becoming less marked as one approached the tip. About one-half the stalk was edible.

"The lot held 72 hours showed similar changes in a still more marked degree, more yellowing, more furrowing or wrinkling of the stalks, decidedly more fibrous material, and the development of a strong, bitter flavor, more marked at the base and extending within about 1½ inch of the tips. The full length stalks were not edible, but the tips might pass for low grade.

"The lot held for 96 hours had a poor, sickly, yellowish-green cast, and was decidedly wrinkled and very tough and bitter throughout its entire length. It was not good, the bitter principle being strongly developed. This asparagus (previous to canning) was kept in a moderately cool place, but had no water turned on to keep it moist. It was not subjected to unusual drying. The loss in weight per hundred the first day was about 4
pounds, and most of this was probably from water which had been held between the stalks after the field washing. On the succeeding days the loss was only from 1 to 3 pounds per hundred. The shrunken appearance after 72 hours gave the impression of a much greater loss in weight.

Further studies upon the deterioration in asparagus were made by Katherine Golden Bitting, and published as Bulletin No. 11 from the National Canners Association in 1917. These may be summarized as follows: The asparagus shoot represents a most unstable condition of plant tissue and rapidly undergoes changes which are distinct from that of wilting as observed in the vegetables. The fresh spear is plump and the tissues turgid. It will break if only a moderate force is used to bend it. Within a short time changes begin, the surface shows light furrows beginning at the base and gradually moving toward the tip. There is some loss of moisture, the tissues being less turgid, the spear can be bent and there is development of fiber, most noticeable beneath the surface, but also taking place in the bundles throughout the tissue. This development of the fiber is easily demonstrated by staining the tissues and by microscopic examination, but is equally apparent in the stalks upon cooking. These changes are not limited to the strengthening of the fibrous portion by lignification alone, but the flavor is affected in like manner, a bitter principle being developed. This follows in the same order as the lignification; that is, from the base towards the tip.

Prof. F. W. Morse, of the Massachusetts Experiment Station, worked upon the same problem from the chemical standpoint, and found that in 100 grams of fresh asparagus there was 7.64 grams of dry matter and 1.83 grams of sugar; that chilled asparagus after 72 hours contained 7.25 grams of dry matter, 1.10 grams of sugar, and that unchilled asparagus after 72 hours contained 6.80 grams dry matter and 7.7 grams of sugar.

These changes are recognized in a practical way at the factory in that provision is made to pack the cut material at once, and in the event of a carry-over and warm weather to use it for tips. It was also found that these changes go on in asparagus though cool, but that they can be greatly delayed if the cut end of the spear be kept in water. The thorough wetting of the spears at the factory has more than a cooling effect to retard bacterial activity on the surface. A warm temperature stimulates both biological and chemical changes. These experiments lend support to bringing in the entire stalk from the field to the factory rather than trimming as is customary.

Labor

In order to present a clearer picture of the exceptional amount of labor required and the equipment needed to pack a thousand cases a day at the height of the season, the matter may be summarized as follows: Land, 1,000 acres; harvesters, 125 men; gatherers, 10; washers, 15; truckmen and helpers, 4; overseer, 1; or a total of 150. These are exclusive of the regular farmers.

In the plant two lines are required, one for the regular Tall Square asparagus can, and one for the Short Square asparagus can, with additional capacity to handle soup stock in round cans.

Three tables for grading, sorting, and cutting, built for twelve operators each, are needed, 36 operators.
Three asparagus cutters, motor driven; one operator for each.

Three blanching tanks, 5 by 8 feet, with steam crosses; 5 persons are required.

Six asparagus filling tables, ten bins each, for 55 persons.

One straight line briner for Tall Square cans.

One straight line briner for Short Square cans; 2 operators to make and look after brining.

Two exhaust boxes with brass guides and brass steam pipes.

Two Gray type closing machines; 2 operators.

One adjustable closing machine for round cans.

Four 4-car retorts, 55 inches by 14 feet, with automatic equipment for controlling the steam, air, and water, and time and temperature recorders; 5 operators for the retorts and for keeping the required records.

Weighing, trucking, handling cans, marking, and other labor will require about 25 more or a total of 133. This is probably more nearly for minimum labor requirements, but about the average for the physical equipment.

Asparagus As a Food

While asparagus has been esteemed as a food for a very long time and given an elevated place among the vegetables, its esteemed value is not due to any high nutritive qualities, but to the pleasure it affords when eaten. The flavor is not the kind to stimulate a craving, and yet it is distinctive and satisfying, and that, too, without being taken in large quantity. It was necessarily seasonal before canning came into vogue. It could be obtained from the beds only in the spring, and any advance in the season meant a large increase in cost for hotbeds. It is still seasonal to a large extent. The fresh material is shipped all over the country in the spring, and it is during that same time that the use of the canned reaches its maximum. The Greeks and Romans dried stalks so they might have a supply out of season, but the flavor is materially altered by that method of preservation, and at present there is little if any prepared in that manner. Pickling has also been used, but it destroys all the natural qualities. Canning is the most satisfactory method of preservation. It has the distinct advantage of being available at all times and of a fresher quality than most of that upon the vegetable market.

The composition of asparagus as given by Atwater, and also by Wiley, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrates</th>
<th>Fiber</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>93.60</td>
<td>1.60</td>
<td>.20</td>
<td>3.1</td>
<td>.70</td>
<td>.3</td>
</tr>
<tr>
<td>Maximum</td>
<td>94.30</td>
<td>2.10</td>
<td>.30</td>
<td>3.6</td>
<td>.80</td>
<td>1.6</td>
</tr>
<tr>
<td>Average</td>
<td>94.00</td>
<td>1.80</td>
<td>.20</td>
<td>3.3</td>
<td>.80</td>
<td>.7</td>
</tr>
<tr>
<td>Cooked</td>
<td>91.60</td>
<td>2.10</td>
<td>3.30</td>
<td>2.2</td>
<td></td>
<td>.8</td>
</tr>
<tr>
<td>Wiley</td>
<td>93.96</td>
<td>1.83</td>
<td>.25</td>
<td>2.2</td>
<td>.74</td>
<td>.67</td>
</tr>
</tbody>
</table>

In the cooked asparagus the high fat content was due to the butter used in its preparation. The same asparagus showed 105 calories per pound.

It is evident from the foregoing that the value of asparagus depends upon some quality not found by the usual chemical analysis. Osborne and Mendel rate asparagus as being very rich in vitamin B.
High medicinal qualities have also been ascribed to the plant and particularly by the laity in those countries where the plant grows wild. It has been held in the same estimation by some people as ginseng is held by the Chinese, and that estimate persists in places. The seeds, growing tips, and sprouts were used, depending upon which were available. The parts are macerated and boiled until a strong decoction or tea was obtained, and this was used according to the requirements of the case.

Galen, the most noted Greek physician living in the second century, describes the virtues of the plant as follows: "Heating, cleansing, and desiccative. It relieves inflammation of the stomach, relaxes the bowels, makes urine, and helps the weak. It removes obstruction of the liver and kidneys, but it is more helpful if pepper be added to the vinegar." As his teaching of medicine was practically undisputed for thirteen centuries, that may be accepted as the medical dictum for a long time. It is still much used by European peasants.

The latest edition (20th) of the U. S. Dispensatory does not omit the plant, but sums up the whole matter in two sentences. "There is at present no sufficient reason for believing that asparagus is of value in practical medicine. The peculiar heavy odor which it imparts to the urine has been the chief foundation for the belief in its diuretic properties."

A crystallizable principle, asparagin has been obtained from the different parts of the plant. It is not exclusively a property of this plant, though it occurs in greater abundance than in others.
BEANS

*Phaseolus vulgaris*

The common string or pod bean, kidney bean, the haricot of the French, French bean of the English—all varieties of the same original species—is probably the oldest cultivated plant native to this country as it was so thoroughly domesticated at the time Columbus arrived that later its original habitat could not be ascertained. The evidence supporting this is so well summarized by Gibault that it is translated and quoted:

“When the Europeans landed in America, the haricot was cultivated by the natives from one end to the other of the New World, a fact often remarked by the earlier explorers. There is no lack of mention of these ‘feves’, harvested by the Indian tribes, as being different from those of Europe.

“Asa Gray collected the accounts of the voyagers who alluded to this bean, the words used in describing it indicating sufficiently to him that they did not know the plant, so consequently must have been foreign to Europe.

“Three weeks after landing in the New World, Columbus saw, near Neuvitas in Cuba, fields planted with ‘faxones et fabas’ very different from those in Spain, and two days afterward, he found even a land well cultivated ‘with fexoes and habas’ very different from ours. *Fexoes* or *faxones*, synonyms of *frejoles*, are the Spanish names of *Phaseolus vulgaris* and it is merely a chance that these names are like Phaseole, because they belong to the Caribbean tongue. Cabeca de Vaca found the ‘Feves’ cultivated by the Indians of Florida and west of Mississippi ‘some fields of corn, haricots, and pumpkin.’ Oviedo (1525-35) speaks of fesoles ‘of which there are many species in the Occidental Indies.’ He cites them at San Domingo, on the other islands, and more abundantly still on the continent. In the province of Nagranda (Nicaraugua), said he, ‘I have seen harvested hundreds of bushels of these fesoles.’ Lescarbot verified this in 1608, stating that the Indians of Maine, like those of Virginia and Florida, planted their corn in ridges and that in the intervals they sowed beans of varied colors and delicate taste. Jacques Cartier, who discovered the St. Lawrence in 1553, found among the Indians at the mouth of this river, corn, and ‘feves’ much used.

“The archeologic discoverers also established that the culture of the haricot was general in America before the arrival of the Europeans. Dr. Wittmack determined some of the seeds of *Phaseolus vulgaris* found in the ancient tomb of Ancon near Lima (Peru). In 1869, Captain F. Burton exhumed some haricots from Peruvian sepulchers built anterior to the discovery of America. M. Wittmack has also identified other prehistoric haricots from the tombs of Arizona, Utah, and the cliff ruins in the United States.

“As a result of these facts, it must be admitted that the culture of the haricot is prehistoric in the New World. The natives possessed numerous varieties, and each American people had a particular name to designate this alimentary plant, indicating an ancient culture, and in addition to this the haricot has not been found in the Old World as is the case with the pea, bean, and lentil, Leguminoseae used by man since most remote times.”
The kidney bean was carried to Europe early in the 16th century but did not become common until the middle of the century following. When its use was learned, it had a profound effect upon the culinary art. Upon this Gibault also comments as follows: “Introduced from America in the 16th century, the vulgarizing of the common haricot only goes back to the middle of the 17th century. The potato came later still in alimentation and yet these two vegetables, recent, so to speak, have modified the secular gastronomic habits. They have replaced in the ragouts and other culinary preparations the turnip and the bean (feve) which formerly played the principal role as accompaniments for meats. They have produced considerable diminution in the consumption of the dry pea and lentil, perhaps caused the skirret (chervis) to disappear and reduced the parsnip to being henceforth only a simple condimentary plant.”

Horticultural Characteristics

The term bean is used in a very elastic sense for certain leguminous plants that have more or less flattened rather than round seeds in pods. The common bean, Phaseolus vulgaris, belongs to one of the large orders of plants, the Leguminoseae, within which is embraced many of the most important seeds from the standpoint of food production, including several species of the beans, peas, lentils, etc. These plants are further distinguished by the fact that many of the members have the ability to utilize or fix some of the nitrogen from the air and thus make it available to the soil. They have a distinctly higher food value than the average vegetable, and this is especially true for the protein content. There are a number of species designated, as already stated, by the general term bean, the majority of which are used for forage and stock feed.

The bean under consideration here is used as a pot-herb and for canning purposes, and is normally a twining plant, though certain varieties have been dwarfed and made to take a bush habit; the former generally grow from 4 to 7 feet in length, the latter usually under 2 feet in height. The leaves are three-parted, generally thin, somewhat hairy, and with a fairly long petiole. The flowers occur in small clusters arising from the axils of the leaves and are light colored—white, pink, reddish, or yellowish. They are followed by a large, long, many seeded pod, which may be nearly round or very much flattened, a character which also applies to the seeds. The plant retains its tropical character, being easily killed by frost at either end of the season.

The field or garden bean includes probably 500 varieties, or at least catalogued varieties, which show considerable range in color, markings, size, shape of the seed, variations in the pod, and habits of the plant. The groups of pea and navy beans, red, white, and medium kidney beans, kinds used for their seeds, and the green and wax podded beans, used chiefly for their succulent pods, are included in this group.

The bean normally has rather fibrous bundles, so-called “strings,” along the edges of the two valves where they join to close the pod. They are least marked in the young but are prominent and objectionable in some varieties as they approach maturity. Intensive studies have been made to develop strains with only rudimentary fibro-vascular bundles, and as a result, they have been reduced to being practically stringless until more than two-thirds grown, and with only slight development after that time.
as compared with the older varieties. These have come from the “1000 to 1 Refugee” strain since 1910. The same thing has also been done for the wax type. It is noted that the round pod is preferred for the green bean and the flat pod for the light or wax bean.

The bean is still very plastic as is clearly shown in the changing from one variety to another in canning. Ten years ago and even less, Kentucky Wonder, 1000 to 1 Refugee, and Giant Stringless Greenpod were favorites but are now giving way to Stringless Green Refugee and Burpee’s Stringless Greenpod. Not quite so much change is taking place with the wax beans; Stringless Refugee Wax is popular though possibly giving way to Burpee’s New Kidney Wax. Wardell’s Wax is stationary. Some horticulturists working on the bean predict further improvement within the next few years.

There is little difference between the green and the wax beans other than the color. The green is somewhat the hardier to varying climatic conditions, yields better, and shows less spotting of the pods.

One variety, the Horticultural or Cranberry bean, is canned for local consumption in New England solely for its quality. The pods are large, roundish, and irregular so that it makes a poor appearance but this is more than compensated for by the flavor.

The bean is found in nearly every kitchen and market garden over the entire country. Large quantities are grown in the South for shipment to northern markets in the off season of local production. The principal growing sections for canning, however, are in Maryland, New York, Maine, Michigan, Wisconsin, Colorado, and California. Only the dwarf varieties are used for field crops in all sections except California as it makes culture easier and eliminates the expense of poles, brush, or other support for the vines. The beans are planted about a foot apart in rows from 3 to 3.5 feet apart. They need fertile soil and clean cultivation to make a good yield. The crop varies from 1 to 5 tons per acre, the average being about 2.2 tons. The plant is subject to disease and to insect attack. The price paid to the growers varies from as low as $45 per ton in some states to as high as $100 in others, the average being about $62.50.

Canning of Beans

The canning of string beans is practically as old as the industry but has been held to small volume in comparison with peas largely because of lack of mechanical appliances for their preparation. The snipping and stringing of the beans were hand operations involving labor costs which prevented them from being an economical food. The development of a practically stringless variety at the close of the first decade in this century simplified matters greatly, consequently in the decade following it stimulated a number of persons to devise machines for snipping. Most of these did not prove practical but at least one has been evolved that does satisfactory work and has a fairly large capacity. As a result of the combined work of the horticulturist and mechanic, production has increased amazingly so that the pack of green beans amounted to 4,871,271 cases and of wax beans 1,195,820 cases in 1931, though the high point was reached in 1929 when 7,245,000 cases of green beans and 1,283,000 cases of wax beans were packed. Formerly the pack was handled in a small way by many packers but under
the newer conditions it is being taken over by fewer large packers, some
canning from 30 to 40 tons per day. One ton yields about 85 cases when
hand snipped and it is claimed that this is increased to from 95 to 100 cases
when machine snipped.

Harvesting

The harvesting of the string bean is strictly hand work as the beans
continue to flower and develop new pods over a period of several weeks.
The pods must be taken when of suitable size which requires judgment
not exercised by a machine. The small beans are the most difficult to pick
without injuring the vines, besides requiring so many more to make a
 pound that pickers are inclined to pass them. They are the most valuable
to the canner, but he is fortunate if he can get more than about 40 per
cent of Nos. 1, 2 and 3, even though he does pay a premium for them.
The vines have to be gone over at least twice a week and if the growing
conditions are exceptionally favorable every other day, so that there are
not a great many pods at any one picking.

A very late development is to cut the beans in the field and to strip the
pods at the factory by means of a machine. To make such mechanical har¬
vesting a success will require that a strain of beans be produced which
mature a number of pods at one time the same as with peas.

The beans are generally picked into bags or baskets suspended from the
shoulder so as to leave both hands free. In the East, more especially in
New York state, the beans are transferred to net or onion bags holding
between 50 and 60 pounds. Others use boxes, baskets, barrels, or bags of
any kind. In the West the handling is done in lug boxes and these un¬
doubtedly afford the best protection and ventilation but are not quite so
convenient to return to the grower.

The bean, like the pea, needs to be handled promptly to get the best
results and to reduce possible infection to the minimum. The danger from
standing over night is not so great as with the pea, but it is safer to make
a clean-up whenever possible. Picking is generally carried on so late in
the afternoon that canning them is not possible the same day, but in time
it will probably be found best to start field work earlier in the morning
and stop in the middle of the afternoon, also to start and stop the factory
operations later. If carried over night, the pods should be in thin layers
to prevent heating or sweating. Beans wet with rain should not be kept in
sacks or piles under any circumstances as decomposition changes take place
rapidly when they start to heat.

Cleaning and Grading

The first operation at the factory is to run the beans through a cleaner
and grader, the cleaner in this preliminary operation being a good fanning
mill to blow out all leaves, stems, and loose dirt which may have been
caught in the picking and handling.

The first bean graders consisted of four vibrating screens, each section
of which was made up of a frame from which projected metal rods spaced
12, 14, 17, and 20 sixty-fourths of an inch apart. The next grader used
flat metal fingers spaced in a similar manner. The spacing for the grades
was agreed upon by bean canners in 1912. The beans were fed upon the
frame with the narrowest openings first, the smallest beans passed through
and the larger beans over the end to the next frame and so on to the last. The screens in which rods were used were given a lateral vibratory movement to distribute the beans lengthwise over the rods, and the graders with bars had a backward and forward movement and also above the pairs of bars a belt with flexible fingers to pass between the bars to remove any beans which might cause clogging.

In machines of this character, all the beans are first dropped upon a No. 1 screen so that the oversize must pass over each screen successively until properly separated.

In the latest type of grader, the separation is done in cylinders, the beans being made to fall upon end into slots with spacings of 14\(\frac{1}{2}\), 17\(\frac{1}{2}\), 21, and 24 sixty-fourths of an inch as it was found that owing to the difference in the method of screening, the beans were smaller than by the earlier types of graders so that in order to adhere to the sizes considered standard in the trade, the slots were increased to the dimensions given. In this type of grader, advantage is taken of a principle developed in pea grading, of feeding the beans on the intermediate or No. 3 cylinder first, separating out the smaller sizes, passing them directly to the No. 1 cylinder where the smallest or No. 1 size is taken out and then through the No. 2 cylinder where the No. 2 size is taken out and the No. 3 size passes over the end. The beans which passed over the slots in the first or No. 3 grader enter the No. 4 cylinder where the No. 4 size is separated and the No. 5 size passes over the slots. This scheme greatly reduces the number of beans which must pass through the Nos. 1 and 2 cylinders thus insuring both greater capacity and better grading. This type of grader has a capacity of about one ton per hour, somewhat more on clean stock and less on that which is curved or crooked.

The first bean grader was not invented until 1903, the next in 1919, and the more recent type in 1924.

The number of beans per pound for the different sizes varies somewhat but the following figures are believed to be very nearly the average for the green Refugee. They were obtained by the Chisholm-Ryder Co., Inc., from installations in various parts of the country. No. 1 size, 350 beans; No. 2, 190 beans; No. 3, 130 beans; No. 4, 100 beans; and No. 5, 80 beans per pound.

It requires one man to feed and attend a grader. The beans on leaving the grader may go directly to hoppers to feed a pair of snippers or they may be discharged into baskets for distribution to the snippers. Where two or three graders are arranged so as to discharge on the same belts, it is considered advantageous by some canners to place one woman at each of the Nos. 1, 2, and 3 lines to take out the flat pods, as less labor and inspection is required to take these up at this point than later.

**Snipping and Stringing**

Snipping and stringing are terms applied to the operations of breaking or cutting the ends and drawing off the fibrous bundle at the back and front junctures of the pod. When done by hand, the tip is broken backward and the string attached drawn toward the stem end, next the stem is broken forward and the string drawn toward the tip. Each bean has to be handled separately in two operations. A hundred pounds of snipped beans is considered a fair day's work.
More snipping devices have been invented than any other type of machine used in the handling of beans. The snipper now most used by canners is of a cylindrical type having hazards on the inner circumference which aid the beans when falling to get their tips through holes or slots in the drum. The amount of the bean projecting through the slots is determined by the taper of the bean ends, and at the proper point in the rotation of the drum a knife clips off the projecting part and at another stage of the travel of the drum the bean falls back on the inside with the chances that the other end of the bean will likewise be clipped off before it leaves the machine. A very few beans pass through with only one end clipped and in some cases one end may be clipped a second time. In this style of snipping the beans must be graded first and three snipper cylinders used, each with a different size of opening. The machines give a maximum efficiency when operating on not more than two sizes.

Snippers have much less capacity than the grader and this also varies with the size of the bean. For the No. 1 size, two machines are arranged tandem; that is, one discharging directly into the next, the pair have a capacity of about 90 pounds per hour; the No. 2 and No. 3 each have a capacity of about 250 pounds; and No. 4 and No. 5 each about 425 pounds. The capacity of the latter may reach 500 pounds per hour on fine stock. One grader unit will furnish beans for two No. 1 snippers arranged tandem and for two each of the other sizes, ten machines in all. This gives sufficient flexibility to handle almost any variation that may occur in the harvesting of beans during the season. Arranging the machines in tandem to handle No. 1's provides a greater capacity at less expense than working them singly but this does not apply to the other sizes.

The loss in snipping increases with the size, being least for the No. 1, though the percentage of loss to the weight of the beans in the grade is the reverse. The waste from each size has not been obtained but the average for all sizes under normal conditions approximates 7.5 to 8 per cent, as low as 5 per cent and as high as 10 per cent. The waste in hand snipping is higher, especially for the smaller sizes running from 225 to 350 beans per pound, which means removing from 450 to 700 ends. To seize the end only takes too much time, consequently too large a piece is broken off. Large numbers of pods are also broken and thrown into the waste which in turn increase the cost since that size brings the highest price.

After the beans are snipped in the machines, they pass onto an inspection belt in order that beans which escape being snipped at either end or are incompletely snipped may be taken out along with those which may be spotted, crooked, or of an unattractive appearance. This gives the best point for a complete inspection. The first women at the belt give their entire attention to snipping the beans that failed to be snipped and they return these to the belt after hand snipping rather than to pass them through the machine a second time. The failure to be snipped in the first trip through the machine is most often due to the beans being crooked so that a gain is made by hand snipping rather than repeating the attempt in the machine. Six women are required at a No. 1 belt, four at Nos. 2, 3, and 4, and three for the No. 5. These figures are only approximate as variations very naturally occur due to the condition of the stock.

After snipping, the Nos. 1, 2, and 3 are prepared for the cans while the Nos. 4 and 5 are cut to definite lengths.
The foregoing is descriptive of the process when grading and snipping for the entire line of commercial grades. It is obvious that a packer can make such modifications as he desires in combining sizes and in cutting to meet a particular trade. Instead of the unit grader, he can use pre-graders to advantage in some instances.

Cutting

The large beans are almost always cut as strings develop to a greater or lesser extent and the whole bean presents a coarse and frequently an irregular appearance. Flat beans picked from the grade belt are mixed with the No. 4 beans. Some of the No. 3 beans may be cut for an especially fancy trade but since they generally bring a higher price when whole, there is little objection in cutting except to fill an order. The practice of cutting was introduced as a means of making the strings less objectionable and before the present varieties had been developed, but is continued as it makes the larger sizes more presentable. The length of the cut may be from 3⁄8 to 1 inch. Apparatus for cutting was the first to be developed in this branch of the industry, the first patent being taken out in 1901. The capacity of the various machines runs from 30 to 60 bushels or 900 to 1,800 pounds per hour.

Washing

The bean pod has a slightly gummy surface so that dust and dirt adhere to it in the picking, handling, and grading operations. A short wash under strong sprays is needed for cleaning purposes before blanching and may be done in any of the better types of washers. Simply immersing and stirring in a tank has been found insufficient and it is inexcusable to allow dirty beans to go into the blancher.

Blanching

Blanching consists in little more than a hot water wash for prime beans, especially in the smaller sizes, and yet they must be heated sufficiently to become flexible so as to pack well. Two minutes suffice for prime Nos. 1, 2, and 3 sizes and from 3 to 4 minutes for the Nos. 4 and 5 sizes. If, however, the stock be old or the growth be arrested by dry weather, the larger sizes may require 5 or 6 minutes. Beans requiring more than 4 minutes may be made soft but not of prime quality. The almost universal practice is to blanch at a temperature between 200° and 212° F., though a somewhat lower one, about 180° to 185°, continued for a longer time, might prove preferable, especially for Nos. 1 and 2. The French use a 12 to 15 minute low temperature blanch but do not indicate the degree used.

If the pods show a tendency to soften to excess or to slough in the blanching, it has been found advantageous to use hard water, or at least this has been reported as desirable by one of the large packers. Under most circumstances, however, the better practice is to use soft water and to regulate the heat accordingly.

The beans need a light spray with cold water immediately upon coming from the blanch in order to freshen and put them in good condition for filling into the can. If not chilled, they remain limp, pack close together, and mat in the can so that heat penetration is irregular; furthermore, they present a less attractive appearance when taken out.
One blancher has a capacity equivalent to 1 grader or 10 snippers, but it means some beans have to stand longer than is desirable to accumulate batches so that it is preferable to use two blanchers though not operating continuously.

**Filling**

The filling of the cans is largely by hand and probably the most satisfactory auxiliary is the rotary filling table. The beans are fed upon the table directly from the blancher and the cans delivered to, and carried from, the table mechanically. It is a cleanly method and while not rapid by comparison with automatic pea fillers, it has fair capacity. The women fill as uniformly as they can judge by the eye and the fill is checked by weighing the cans as they leave on the conveyor. Another method, and one still in use, is to provide a frame to hold either 2 or 4 dozen cans above which is a hopper with a bottom having holes cut to correspond with the openings in the cans. The beans are poured into the hopper and distributed in the cans. The frame is attached to a shaker so as to get an even filling but the final correction of the fill must be by weight. Beans need to be filled above the cut-out weight if they have been given a short blanch as they will lose a certain amount in the exhausting and cooking. The allowance to be made is best determined by experiments upon stock and under the working conditions at the factory. The Nos. 4 and 5 cut beans will show most variation in the final product due to the displacement of the air in the pods by the brine in the can. The brine is made to contain from 1½ to 2 per cent salt and is preferably added hot.

**Exhausting**

A thorough exhaust is needed for beans which are given a light blanch in order to insure that all air or gas be driven from the pod; and is also advisable for beans that are a little hard as it has the effect of a longer blanch without the disadvantage of subsequent handling. It insures a proper vacuum and a uniform temperature on going into the cooker.

**Cooking**

Formerly beans were cooked in open baths or in water in retorts with the cover let down but not clamped. The temperature under these conditions might vary from 208° to 214° F. The time varied from 1½ to 2 hours for the No. 3 can and smaller and up to 2½ hours for the No. 10 can. The cook was recognized as being uncertain as even the better packers sustained loss, but considered light at the time. It would not be so regarded now. The argument for the low temperature was that the color and flavor were better than those cooked in accordance with that used for peas. Duckwall, working alone and without any precedent, called attention to the inadequacy of the cooking in an article in *The Canner*, May 15, 1908. He stated that in a case of spoilage which he found, the cause was due to *Bacillus mesentericus vulgaris* or potato bacillus. The beans had been packed in No. 2 cans and processed in an open bath for 2 hours. “A temperature of 240° F. for various lengths of time, according to the beans themselves is absolutely necessary.” Again in the same journal of August 20, 1914, he makes the following statement: “Formerly it was the universal custom to process string beans in boiling water only, sometimes giving No. 2 cans as short a time as 20 minutes with perfect success. Other
packers have used, and still continue to use, a process of 45 minutes in boiling water (212° F.). Some have used this process for years without having any spoilage due to insufficient sterilization. Even though so many string bean packers have had success with the boiling water process it is a positive fact that some day they are going to find this process sadly deficient, and they will be up against a big loss.”

In 1912, Bureau of Chemistry Bulletin No. 151 gave 240° F. for 30 minutes as the best practice at that time. Since then other studies have proven the inadequacy of the open bath for any single cooking period.

The present practices, while lacking in uniformity, are about as follows:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nos. 1 and 2</td>
<td>240° 20 min.</td>
<td>232° 25 min.</td>
</tr>
<tr>
<td>No. 2½</td>
<td>240° 25 min.</td>
<td>232° 30 min.</td>
</tr>
<tr>
<td>No. 10</td>
<td>240° 30 min.</td>
<td>232° 40 min.</td>
</tr>
</tbody>
</table>

The California regulations are Nos. 1 and 2, 240° for 20 minutes; Nos. 2½ and 3, 25 minutes; No. 5, 35 minutes; No. 10, 40 minutes; No. 2 and 10-ounce glass, 30 minutes.

It is recommended that the cooking be followed by immediate cooling.

The Germans give ½ liter cans (No. 2) 245° for 10 minutes, and liter cans (No. 3) 245° for 20 minutes. The French give ½ liter cans 234° for 20 minutes and liter cans 25 minutes. These are in close agreement when one considers some of the other factors which have an effect upon the cook.

Heat penetration takes place readily in string beans if the blanching be not too heavy and the beans be chilled to prevent them from becoming flaccid. Over-blanched and very soft beans, particularly Nos. 1 and 2, may mat in a can so that heat penetration is nearly as slow as in spinach. The short blanch is therefore a safety measure and any additional effect desired can be obtained in the exhausting without producing the matting which comes from handling over-blanched stock. Furthermore, there is less danger of over-filling on lightly blanched beans, for over-filling also checks rapid and uniform heat penetration. The fill on cut beans is a little greater than with whole beans. Heat penetration is slow in beans packed asparagus style, particularly so if the cans are laid on the side in the retort. Such cans should be on end in a stationary cooker. It is to guard against trouble from over-blanching and over-filling that it is safer to use a higher cook than seems warranted from some experiments on properly prepared cans.

The agitating cooker has one advantage in that heat penetration is so rapid and uniform that it need not be continued so long as to cause discoloration.

**Asparagus Style of Packing**

Some beans are packed “asparagus style”; that is, whole cut to the full length of the can and arranged in the can in the same manner as asparagus. The apparatus for cutting the beans and filling the can was developed by A. Greco, San Jose, California, in 1917. In a previous article, the following comment was made upon this style: “This requires much extra work and justified only in glass packing.” Since then it has been demonstrated that the product has met with much favor and has become a factor in fine quality packing in tin.
The beans used for this purpose are of the Kentucky Wonder strain having the vines supported by poles. The pods are permitted to develop to as nearly the No. 3 size as can be judged by the pickers. At the factory, they are hand-graded to remove those obviously off-size or crooked. They are next washed, then blanched for two minutes or thereabouts, then chilled. The beans are laid parallel in forms which are the desired length and when closed hold the correct amount to fill a No. 2 can, or other size selected. Nearly the entire pack is put up in the No. 2 size.

The beans are cut to the length of the form, one end of which is inserted into the open end of the can, then inverted, and the filling done with the beans arranged in position. Brine is added and the usual cook given. It makes an attractive pack that is gaining in favor.

String Beans With Pork

Abroad it is not unusual to add a bit of pork to string beans as we do to baked beans. Only enough, one-fourth of an ounce or a little more to a No. 2 can, is added to impart flavor. In small operations, ham bones obtained from large eating places are boiled in water and the liquor added to the brine in order to impart a certain flavor. One style of foreign packing is beginning to be imitated. The essential feature is to cut the pods lengthwise in strings or on the diagonal as in schnittbohne.

Wax Beans

The wax bean differs from the green primarily in the color of the pod though generally it is flatter. The strains vary from a very pale to a pronounced yellow. The plants are less hardy and not so prolific as the green varieties.

The principal difference in the canning operations is the attention given to sorting for spots and blemishes. Imperfections which pass unnoticed or are considered of minor importance on the green pod constitutes a serious blemish on the light pod. Precaution also must be taken in cooking to avoid too high or prolonged heating, more often the latter, as either condition may cause a reddish hue.

Standards

The Department of Agriculture has established standards for beans which are as follows:

**DEFINITION**

Canned snap beans are the vegetables prepared from fresh, immature pods of any of the varieties of the common garden bean, with ends of pods snipped, washed, with or without precooking (blanching), with the addition of potable water, with or without salt, packed in hermetically sealed containers, and sterilized by heat.

**GRADES OF CANNED SNAP BEANS**

**U. S. Grade A** (fancy) canned snap beans are tender pods of beans of similar varietal characteristics which are substantially whole; are uniform in color; and, unless declared to be ungraded for size, conform to the size claimed for the beans. They are surrounded by practically clear liquor; are practically free from discoloration, tough inedible strings, stems, and other defects; possess the flavor of young, tender, immature beans; and score not less than 90 points when scored according to the scoring system outlined herein.

**U. S. Grade B** (extra standard) canned snap beans are reasonably tender pods of beans of similar varietal characteristics which are substantially whole; are practically uniform in color; and, unless declared to be ungraded for size, conform to the size
claimed for the beans. They are surrounded by reasonably clear liquor; are reasonably free from discoloration, tough inedible strings, stems, and other defects; possess a desirable fresh, young bean flavor; and score not less than 75 points and need not score more than 89 points, when scored according to the scoring system outlined herein.

U. S. GRADE C (standard) canned snap beans are pods of beans of similar varietal characteristics which are substantially whole, and have reached such a state of maturity that the seeds are well developed, but not hard; are fairly uniform in color; and, unless declared to be ungraded for size, are fairly uniform in size. They are surrounded by liquor which may be somewhat cloudy; are fairly free from discoloration, tough inedible strings, stems, and other defects; possess a good flavor; and score not less than 60 points, and need not score more than 74 points, when scored according to the scoring system outlined herein.

Off-Grade (substandard) canned snap beans are canned beans which score less than 60 points when scored according to the scoring system outlined herein, or, when any one of the grading factors, with the exception of uniformity of size, falls in the subdivision D; or, canned snap beans that fall below any standard promulgated under the food and drugs acts of June 30, 1906, as amended.

styles of snap beans

"Cut" snap beans are portions of whole beans cut into lengths varying from 1 to 2½ inches, usually 1 to 1½ inches. The description of grades outlined herein will suffice for "cut" snap beans, the term "substantially whole" meaning, when applied to "cut" beans, that the portions of the pod are intact—not split, shattered, or broken.

"Asparagus style" snap beans are canned beans, the pods of which approximate in length, and are packed parallel to, the longest dimension of the closed container.

prerequisites to grading

Condition of Container

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents, and the ends shall be flat or concave.

Condition of Package and Label

If cased, the canned snap beans shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Federal Food and Drugs Act.

Fill of Container

Cans of snap beans will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned snap beans that do not meet the above requirements shall bear the legend,

"Below U. S. Standard"

" Slack Fill"

A certificate of grade covering canned snap beans that do not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,

"Below U. S. Standard—Slack Fill"

"Contains Excess Added Liquid"

Drained Net Weights

Properly filled cans of snap beans should yield at least the drained weights indicated in the table below. When packed "asparagus style," the minimum drained weight of No. 2 cans shall not be less than 14½ ounces. A can of a size not mentioned shall yield a drained net weight that bears the same relation to the drained weight indicated for the can nearest in size as that existing between the capacities of the cans in question. Drained net weights of No. 2½ size cans and smaller are determined by emptying the contents on a circular sieve, 8 inches in diameter containing 8 meshes to the inch, and permitting to drain for two minutes. Larger size cans are drained over a similar sieve 12 inches in diameter.
The maximum head space allowable in the sizes commonly used in packing snap beans is shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can size</th>
<th>Maximum head space allowable (measured from top of double seam in sixteenths of an inch)</th>
<th>Drained net weight (in ounces)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 (picnic)</td>
<td>8.8</td>
<td>6½ 6½</td>
</tr>
<tr>
<td>No. 1 tall</td>
<td>9.9</td>
<td>9¾ 9¾</td>
</tr>
<tr>
<td>No. 300</td>
<td>9.5</td>
<td>8½ 8½</td>
</tr>
<tr>
<td>No. 303</td>
<td>9.4</td>
<td>9½ 9½</td>
</tr>
<tr>
<td>No. 2</td>
<td>9.7</td>
<td>11½ 12</td>
</tr>
<tr>
<td>No. 10</td>
<td>13.6</td>
<td>61 65</td>
</tr>
</tbody>
</table>

Artificially Colored Snap Beans

Certificates of grade covering canned snap beans that are artificially colored shall bear the following statement in addition to the statement of grade:

"Below U. S. Standard—Low Quality but not Illegal Because Artificially Colored"

ASCERTAINING THE GRADES

The grades of canned snap beans may be ascertained by considering the following factors: Clearness of liquor, uniformity of color, uniformity of size, absence of defects, maturity, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Clearness of liquor...</td>
</tr>
<tr>
<td>II. Uniformity of color...</td>
</tr>
<tr>
<td>III. Uniformity of size...</td>
</tr>
<tr>
<td>IV. Absence of defects...</td>
</tr>
<tr>
<td>V. Maturity...</td>
</tr>
<tr>
<td>VI. Flavor...</td>
</tr>
<tr>
<td>Total...</td>
</tr>
</tbody>
</table>

Note.—When grading snap beans declared to be ungraded for size, the factor of "uniformity of size" shall be disregarded. The other five factors shall be scored, the total of which shall be multiplied by 100 and divided by 90 for the final score, dropping any fractions.

Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means 12, 13, and 14.

I. CLEARNESS OF LIQUOR.

(A) To receive a rating within the highest group, 9 to 10 points, for this factor, the liquor surrounding the beans must be practically clear—that is, presenting not more than slight cloudiness.

(B) If the liquor possesses but a small quantity of visible sediment, a credit of 7 to 8 points may be allowed.

(C) If the liquor is somewhat roily, with an accumulation of sediment readily noticeable, or is slightly off color, a credit of 5 to 6 points may be allowed.

(D) If the liquor is badly clouded, possessing a considerable quantity of sediment, or is badly off color, a credit of 0 to 4 points may be allowed.

II. UNIFORMITY OF COLOR.

(A) If the color of the pods is uniform and is typical of the variety, and bright, a credit of 9 to 10 points may be allowed.

(B) If the pods are somewhat deficient in color, a credit of 7 to 8 points may be allowed.

(C) If the pods are fairly uniform in color but are dull, or if the color is variable, a credit of 5 to 6 points may be allowed.

(D) If the color of the pods is poor, being dull or off color, a credit of 0 to 4 points may be allowed.
III. Uniformity of Size.—Canned snap beans of the so-called round varieties, if graded for size, shall meet the following size requirements:

No. 0 size snap beans are snap beans that are \( \frac{3}{8} \) of an inch, or smaller, in diameter.¹

No. 1 size snap beans are snap beans that range from \( \frac{3}{8} \) to \( \frac{11}{64} \) of an inch in diameter.

No. 2 size snap beans are snap beans that range from approximately \( 14\frac{3}{4}/64 \) to \( 18\frac{3}{4}/64 \) of an inch in diameter.

No. 3 size snap beans are snap beans that range from approximately \( 18\frac{3}{4}/64 \) to \( 21/64 \) of an inch in diameter.

No. 4 size snap beans are snap beans that range from approximately \( 21/64 \) to \( 24/64 \) of an inch in diameter.

No. 5 size snap beans are snap beans that range from approximately \( 24/64 \) to \( 27/64 \) of an inch in diameter.

No. 6 size snap beans are snap beans that are over \( 27/64 \) of an inch in diameter.

(A) If the pods are practically uniform in size and symmetry—that is, in the two smaller dimensions—a credit of 9 to 10 points may be allowed.

(B) If the pods vary slightly in size and symmetry, containing not more than 5 per cent by count of so-called flat beans, a credit of 7 to 8 points may be allowed.

(C) If the pods are noticeably lacking in uniformity of size and symmetry, containing not more than 10 per cent by count of so-called flat beans, a credit of 5 to 6 points may be allowed.

(D) If the pods are markedly lacking in size and symmetry, a credit at 0 to 4 points may be allowed.

IV. Absence of Defects.—The factor of absence of defects has reference to the degree of freedom from such defects as split pods, tough inedible strings, pods with unsnipped ends, blemishes, poorly and irregularly cut pods, stems, and loose ends.

(A) If beans are practically free from the defects mentioned, a credit of 14 to 15 points may be allowed.

(B) If beans are reasonably free from such defects, a credit of 12 to 13 points may be allowed.

(C) If the defects are prominent, a credit of 10 to 11 points may be allowed.

(D) If the defects are decidedly prominent, a credit of 0 to 9 points may be allowed.

V. Maturity.—The factor of maturity refers to the stage of development of the seed pod and the seed. Consideration is also given to the texture and tenderness of the seed pod and seed.

(A) To receive a rating within the highest group, 31 to 35 points, for this factor, the beans must be very tender. The seed must be very small and in the early stage of development.

(B) If the beans are tender but slightly more mature than those in group (A), with seed small but somewhat more developed than in group (A), a credit of 27 to 30 points may be allowed.

(C) If the beans are tender but offer some resistance to pressure between the fingers, the seed being developed to the extent that they are somewhat prominent but not hard, the pod not having passed the stage of succulence, a credit of 23 to 26 points may be allowed. Beans that fall in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) If the beans are well developed and prominent, the seed being quite firm and the pod fibrous, a credit of 0 to 22 points may be allowed.

VI. Flavor.—The quality of flavor of canned snap beans shall be classified from the standpoint of palatability.

(A) If the beans possess the typical flavor of very young, tender beans, a credit of 18 to 20 points may be allowed.

¹ Diameter is determined by measuring the pods at their minimum dimension—that is, transverse to the axis.

² Flat beans refer to beans, the width of which is approximately one and one-fourth times the diameter—that is, the smallest dimension.
If the flavor is somewhat lacking in the highly desirable characteristics, a credit of 15 to 17 points may be allowed.

If the beans possess a fair bean flavor, a credit of 12 to 14 points may be allowed. Beans that fall in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

If the flavor indicates that the beans have reached a mature stage, the flavor being more or less disagreeable, strong, or aged, a credit of 0 to 11 points may be allowed.

Label Weights

Green and wax (Sp. Gr. 1.01): 8Z Short, 7¼ ozs.; 8Z Tall, 8 ozs.; Picnic—No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 15½ ozs.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs.; No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 5 ozs.

Packing In Glass

Beans were packed in glass by Appert at the time of his original experiments, before 1810. At that time he cooked the whole beans for an hour and a half and for pods split the entire length into two or three pieces the time was one hour. Shelled beans were cooked for two hours.

Glass has been used extensively for the home canning of beans but in only a limited way in commercial packing, usually on fine packs for display purposes in grocery stores. Some beans are packed full length or asparagus style, other in half lengths, and arranged in the jar to attract attention, but not on a quantity production scale.

Cooking in glass needs to be under pressure for either home or commercial canning. The cook in jars ranging from 12 to 24 ounces capacity needs a temperature of 240° for 40 minutes unless a lighter cook be found safe by more extensive laboratory experiments in the future.

Spoilage

Spoilage in beans is usually of the flat sour type. This was clearly brought out by Duckwall in the 1914 note already cited and not a great deal has been contributed since. "The bacteria which cause spoilage in string beans are generally of the spore-bearing type which do not generate gas; that is, string beans when spoiled are usually flat sours, swells being not nearly so common as they are with peas. When a boiling water process is used on beans the percentage of swells in the spoiled cans is greater than when 220° or 230° is used. Beans given this latter temperature, and not sufficiently sterilized will almost always be flat sours. There is one type of bacteria which cause spoilage in beans which is seldom found on peas; this is a very short rod and grows very slowly, does not generate any gas, but produces a large amount of acid. It is a rather difficult germ to find under the microscope on account of its size, and seems to be one of the hardest to destroy. It is nearly always found in beans which are very sour. "Whenever the beans will stand it, the only proper temperature to use is 240° F., generally 30 minutes for No. 2 cans. The time depends somewhat on the conditions of the beans, very frequently 20 minutes, or even slightly less, is long enough."

Composition

While the bean has the reputation of being a highly nutritive food, this quality does not apply to the green pod, though it is good and wholesome
and above the average of succulent vegetables. An analysis of string beans by Wiley is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>87.23</td>
</tr>
<tr>
<td>Ash</td>
<td>.76</td>
</tr>
<tr>
<td>Protein</td>
<td>2.20</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>1.92</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>7.52</td>
</tr>
<tr>
<td>Fat</td>
<td>.37</td>
</tr>
</tbody>
</table>

S. R. A. 19. The Use of the Term “Stringless Beans.”

Your inquiry regarding the use of the expression “stringless beans” has been taken up with the Bureau of Plant Industry.

We are informed that the term “stringless” applies more particularly to a condition of growth than to a variety of beans, although there is a great diversity among varieties in respect of stringiness. If the so-called stringless varieties are processed while they are in the proper stage of development, the term “stringless” could be applied very properly to the stock so handled. There is bound to be, however, a greater or less percentage of the product of any variety which will carry more or less fibrous matter (strings). In other words, many of the better sorts of beans, if picked and processed when young enough, will give a brand of goods which could properly be designated “stringless.” If the same varieties are allowed to come to a later stage of development and approach more nearly to maturity, they will become tough and fibrous.

It is the opinion of the bureau that the term “stringless” may properly be used for a high-grade brand of canned beans, regardless of the name of the variety from which the stock was derived, provided they are canned at the proper state of development, as indicated above.

S. R. A. 54. The Term “Stringless” Not Applicable to Any One Variety of Bean.

This bureau has taken up the question of the meaning of the term “Refugee Beans” with the Bureau of Plant Industry.

The term “Refugee” is a class name applied to several distinct horticultural varieties of beans which vary markedly in the quality of stringiness.

As was explained in the bureau’s letter of a few weeks ago (Bureau of Chemistry Service and Regulatory Announcements No. 3, letter 19), the age of the pod is an important factor in determining the amount of fiber or stringiness in the bean. Some varieties develop earlier than others, and on this account those varieties which are slowest in developing the fibrous character are classed by seedsmen as stringless varieties of beans. It is not thought that the term “stringless” should be confined to any one variety of bean.

S. R. A. 315. Weights of Wax and Refugee Beans in Cans of Various Sizes.

An investigation recently concluded by the bureau indicates that properly filled cans should, in general, yield at least the following drained weights of beans, the weights being determined in each instance by draining for two minutes on a one-eighth inch mesh screen:

<table>
<thead>
<tr>
<th>No.</th>
<th>Size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 1/4 by 4 inch sanitary</td>
<td>6.0 ounces</td>
</tr>
<tr>
<td>2</td>
<td>3 1/6 by 4 1/6 inch sanitary</td>
<td>Whole beans 11.5 ounces, Cut beans 12.0 ounces</td>
</tr>
<tr>
<td>10</td>
<td>6 1/6 by 7 inch sanitary</td>
<td>Whole beans (64.0 ounces) 4 pounds, Cut beans (67.0 ounces) 4 pounds 3.0 ounces</td>
</tr>
</tbody>
</table>

Cans of beans of exceptionally high or low specific gravity should yield drained weights which are proportionally higher or lower, respectively, than those given in the preceding list. In all cases, however, the cans should be packed as full of beans as possible without injury to quality. This guiding principle is believed to be consistent with the requirements of weight as here indicated.
Due allowance will be made in all cases for unavoidable variations in weight.

A can of a size not mentioned here should yield a drained weight of beans which bears the same relation to the drained weight indicated for the can nearest in size as that existing between the capacities of the cans in question.

In making declaration under the net weight requirements of the Federal Food and Drugs Act, the total weight of the contents of the can, liquid included, should be declared.


Further extensive investigation confirms the correctness of the drained weights specified for No. 1 and No. 2 cans of wax and refugee beans in item 315, page 114, Service and Regulatory Announcements, Chemistry 24. It has been found, however, that the drained weights given for whole and cut beans in No. 10 cans are rather difficult to attain under certain conditions. It is, therefore, deemed advisable to reduce the requirements of 64 ounces whole beans and 67 ounces cut beans in No. 10 cans to 61 ounces and 65 ounces, respectively.

Due allowance will be made in cases where through failure to blanch it may be found impossible to attain the specified weights. In certain cases the weights may be attained even without blanching, while in other instances blanching may be necessary. The bureau desires to emphasize the fact that whether or not the beans are blanched the cans should always contain the greatest amount of beans it is possible to pack in them without impairment of quality.

Baked Beans, Pork and Beans

The general conception of the baked bean seems to be that it is one of the distinctive New England dishes, originated by the early settlers as the result of the combined skill of the housewives in utilizing their meager resources and that it became a staple culinary preparation which still holds a prominent place in the home and public eating places. A search through several of the earlier works upon cookery dispels all that which concerns its early origin and the “human interest” side. Baked beans are not mentioned in any of the books consulted until 1829* which indicates that the dish is scarcely more than a hundred years old. The recipe given there is as follows:

“Baked beans are a very simple dish, yet few cook them well. They are apt to be either hard, or tasteless. They should soak in cold water, and be placed near the fireplace, the night before they are baked. In the morning they should be taken from that water, and put into a kettle, with just enough water to cover them. They should not boil; but should be kept scalding hot an hour or more. Then put them into a beanpot with a piece of pork slashed across the rind, just covered with hot water, and let them bake three or four hours. A pound of pork is enough for a quart of beans; and that is a large dinner for a common family. Pieces of pork streaked with lean should be chosen. A little pepper sprinkled among the beans, before they are cooked, will render them less unhealthy.

“Steamed beans are prepared in the same way. The only difference is they are not taken out of the scalding water but are allowed to stew in more water, with a piece of pork and a little pepper, three hours or more.”

*Child, Mrs. S. M. “The Frugal Housewife.” Boston, 1829. The name of this book was changed in 1832 to “The American Frugal Housewife,” as there was an English book published earlier of the same name.
The New England Economical Housekeeper and Family Receipt Book by Mrs. E. A. Howland, published in New London, 1848, is exceedingly brief:

"Baked Beans"

"Dissolve a lump of saleratus as big as a walnut with your beans before baking, and you will find them greatly improved."

Mrs. Putnam’s Receipt Book and Young Housekeeper’s Assistant, published in Boston, 1857, gives the following:

"Baked Beans"

"Put a quart of white beans to soak in soft water, at night; the next morning wash them out of that water; put them into a pot with more water than will cover them; set them over the fire to simmer until they are quite tender; wash them out again; and put them into an earthen pot, scald and gash one and a half pounds of pork, place it on top of the beans and into them, so as to have the rind of the pork even with the beans; fill the pot with water, in which is mixed two tablespoonfuls of molasses. Bake them five or six hours; if baked in a brick oven, it is well to have them stand in over night."

The Improved Housewife or Book of Receipts, published in Hartford, Connecticut, in 1844, has the following recipe:

"Take two quarts of middling sized white beans, three pounds of salt pork, and one spoonful of molasses. Pick the beans over carefully, wash and turn about a gallon of soft water to them in a pot; let them soak in it lukewarm over night; set them in the morning where they will boil till the skin is very tender and about to break, adding a teaspoonful of saleratus. Take them up dry, put them in your dish, stir in the molasses, gash the pork, and put it down in the dish so as to have the beans cover all but the upper surface; turn in cold water till the top is just covered; bake and let the beans remain in the oven all night.

"Beans are good prepared as for baking, made a little thinner, then boiled several hours with the pork."

Baked beans, as generally understood, consist of dry, white beans, as navy or pea beans, soaked in water until well plumped, parboiled until somewhat softened, then a piece of scored pork placed in the bottom of a pot or earthen jar with sometimes a small onion, followed by a layer of beans with some pieces of pork on top, and a dressing composed of molasses or brown sugar, water, salt, with a seasoning of mustard and pepper added; the pot or jar may or may not be covered and the beans heated slowly for several hours. The object in placing the pork in the bottom is to distribute the fat evenly throughout the beans by means of heat. The beans take up some of the moisture and some evaporates so that hot water is added at intervals and when the cooking is finished, the beans are whole or nearly so, surrounded by a rich, thick, dark sauce. The soaking is usually carried on over night or about sixteen hours and with the other work and baking require the greater part of a day in preparation. It was, therefore, natural when canning became a practical art that the attempt was made to prepare them on a large scale and conserve them until needed.

Who first canned pork and beans has been a matter of controversy. The process was patented by W. K. Lewis of Boston, in 1877, but there seems
to be good evidence that Burnham and Morrill of Portland, Maine, packed and supplied the article to their fishing fleets for at least two years previously. The title of the patent indicates earlier packing in claiming an “improvement” on the process. The tomato sauce or dressing so universally used during the past forty years was started by the Van Camp Packing Company, Indianapolis, Indiana, in 1891.

The Lewis patent is of interest because it discloses the early effort at packing. It is No. 193,880, August 7, 1877, and is as follows:

Improvement in canning beans and pork for food.

This invention relates to certain improvements in preparing and putting up beans for the market.

In order to prepare beans for the table, it has heretofore been necessary to soak them in water until they are thoroughly softened, then to parboil them, and afterward bake them in an oven, with pork and other seasonings.

This is too tedious for general domestic purposes; and the object of my invention is to obviate this objection, and prepare and put up the beans with pork and other seasonings, and supply the same to the market, in condition for immediate use.

To this end my invention consists in soaking and parboiling them as heretofore, after which they are put up with pork and seasonings, if desired, and hermetically sealed in tin or other cans or vessels, and then baked, while thus hermetically sealed, by means of steam heat.

In carrying out my invention, the beans are first well washed, and then soaked and parboiled in the usual manner. After being parboiled, they are packed in cans or other vessels of convenient size for use, with a suitable quantity of pork and seasoning material, and are then hermetically sealed. The cans are then subjected to a baking temperature, by placing them in a suitable chamber, and subjecting them to steam heat for about six hours, or sufficient time to thoroughly bake the contents of the cans, after which they are allowed to cool, when the cans are ready to be labeled and packed for the market.

The advantages of having the beans properly prepared, seasoned, and cooked, and ready for immediate use, will be appreciated by housewives, and all persons who have found it necessary heretofore to prepare and cook the articles; and, furthermore, owing to the confinement during the baking process, the beans will be in a much more palatable condition, and will have a better flavor than when baked by the ordinary process.

In lieu of subjecting the cans containing the prepared beans to steam heat in a chamber, as above described, they can be placed in a receptacle containing water, and the steam forced through the water by means of steam pipes, or in any suitable manner, until the beans are properly baked; and, if desired, the water can, by the addition of salt or equivalent material, be made more dense, thereby aiding the baking process.

Having thus described my invention, what I claim is—

The process, substantially as described, of putting up baked beans for market, the same consisting in first parboiling the beans, then placing them in a can with pork, and hermetically sealing the can, and afterward subjecting the can containing the parboiled beans and the pork to the action of heated water or steam, whereby the same are prepared for immediate use.

This patent designates the product as “baked beans” though heated above that attained in the oven and the can being closed did not permit moisture to escape. It fixed the trade term “baked” twenty-nine years before the passage of the Food and Drugs Act.

The beans used for pork and beans or baked beans are the navy or pea beans, also called large and small white beans, varieties of the same species as the pod or kidney bean but in this instance used for their seed only. These beans are of the bush type, grown in rows in the field and harvested when fully ripe. They are cut or pulled by machinery, dried, threshed, re-cleaned, and marketed in bags of 100 pounds each in the West or by the bushel in the East. Some imported Kotenashi beans are also used. They are similar to the large white variety.
The navy beans are from one and one-half to twice the size of the pea bean, being from one-half to five-eighths inches in length while the pea bean is usually less than three-eighths of an inch in length. The navy bean is not quite as hard and dry as the pea bean. Formerly it was preferred for this style of packing but as the latter is a little more resistant to disease, it has acquired ascendancy with the growers. These beans are grown chiefly in New York, Michigan, and California, those grown in the eastern section having a higher moisture content than those grown in the West due to the difference in climatic conditions. The eastern bean contains from 14 to 25 per cent of moisture, or in some cases in an early wet fall this may exceed 30 per cent. Anything above 16 per cent is prejudicial to keeping quality and above 20 per cent needs artificial drying unless used promptly or during cold weather. The moisture content of the western bean is from 10 to 12 per cent, the skin contains more of the waxy substance so that the beans do not plump so rapidly nor so evenly on soaking in cold water. This objection, however, can be largely overcome by giving a short bath in hot water prior to soaking.

Eastern beans are generally marketed as hand picked, the material which the machines do not remove having been taken out, but western beans are machine cleaned only. The latter contain some small immature beans which have dried and in the later treatment remain hard. Most of these can be screened out. Whether the canner purchases the beans as hand picked, recleaned, or upon sample, hand picking is necessary to grade more closely than is done in the trade and it is desirable also to make a test of the moisture content as the latter gives information upon the number of cans which may be obtained from a bushel or bag. The moisture test is made according to the Brown-Duvel method and is comparatively simple though special apparatus is required. A 100 gram sample of the beans is placed in a flask with 150 cubic centimeters of mineral oil. Heat is applied until 175° C. has been reached, then discontinued and the amount of water distilled off is read on a special graduate which indicates the percentage of moisture in the sample.

Commercial Packing

The packing of pork and beans is not seasonal but can be done at any time according to the condition of the market. The packer is not rushed so there is no excuse for not having a product free from moldy, spotted, or unsound material. The greater part of the work is done during the winter months in order to use the canning plant when it would otherwise be idle, to take advantage of the lower wages demanded, and to utilize moist beans which might deteriorate on the recurrence of warm weather. It is one of the large divisions of the canning industry, the pack amounting to between 17 to 18,000,000 cases annually, practically all of which is consumed locally. The large canning centers are New York, New Jersey, Pennsylvania, and Indiana, with many firms engaged in the industry.

The production of a good article is not the simple matter that many assume it to be as was clearly demonstrated at one time during the war. It was thought that by supplying a formula to packers a uniform product might be prepared instead of the widely different offerings being submitted to the Army and Navy for purchase. Not a single sample of the beans
prepared according to the directions equalled any one of the four nationally known brands and the difference was not one of psychology nor of name.

Factory Operations

The first operation is the recleaning of the beans, for no matter how purchased they always contain some that are damaged, occasional stones, and bits of hard earth. The usual method is to run the beans over a belt, or better still, over a series of short belts in order that the beans be turned over to expose both sides. Four five-foot sections are almost ideal for inspection as the beans are turned and space provided for sorters. Women are stationed on each side of the belt, from one to four to a section depending upon the quality of the beans or rate of handling. All withered, spotted, musty, and anthracnose beans are removed. In the latest development of the sorting table, another section is added for washing, to float off the light beans and to separate any gravel or dirt by gravity. The amount of material removed at this stage varies greatly, from less than a half to two per cent for good beans and a much higher amount for the poorer quality.

Washing

The next operation is that of washing, for while beans appear clean, there is invariably fine dust and grit present on the surface from handling and threshing and frequently some adherent clay. The water which comes away is evidence as to the need of the operation. If the work be not done under a spray washer as part of the sorting, it should be done in a continuous rotary washer for the friction of one bean against another. A special washing system was developed by James McCall at Gibson City, Illinois, that has some novel features. The beans are discharged from the picking belt into a hopper and at the same time water enters the bottom of the hopper causing the beans to rise and overflow upon an incline that has a series of cross pieces to make ripples in the current. The beans wash over these cross-pieces but dirt, gravel, nails, bits of glass, etc., are separated by gravity. A series of pegs at the discharge end catches the lint and strings from the bags. Some packers dump the beans into tanks and turn on water for soaking depending upon that to carry away any dirt when it is drawn off, but a careful examination shows that this is unsatisfactory. The beans do not get proper agitation and instead of the dirt being loosened, it becomes adherent. A preliminary washing gets rid of considerable material which would increase bacterial infection in the soaking irrespective of any other cleansing effect.

Soaking

Dry beans are soaked to cause them to take up moisture and to induce physical changes in structure to make them palatable. Water is absorbed to practically 100 per cent of their dry weight, which is near the limit irrespective of what the initial moisture content may be. The absorption of water varies with the initial moisture content of the beans, and the rate with the temperature of the water, though eastern beans absorb water more promptly than western or those matured in a dry climate.

The soaking is one of the most variable factors in preparation. Originally the soaking was most often done in cold water and carried on overnight or for a period of fourteen to sixteen hours or even more, and it is
doubtful whether any real improvement has been made upon this point. The change in the bean under these conditions is simply that due to absorption of water with very little loss of bean constituents as it is a biological process in living cells. The fibrous portion is swollen and made tender, the beans so treated afford the maximum leeway in handling in the subsequent operations and if the water be renewed about every three hours during the soaking, there is little development of bacteria. The optimum temperature for the absorption of water in the beans is given as 95° to 97° F. with the rate considerably higher than for cold water (65° or below), and though apparently there is little difference in the beans, they must be handled much more promptly through the factory on account of danger of spoilage. When the temperature used is 120° or above, the tissues are killed and the absorption takes place more in the nature of a chemical reaction, water is absorbed rapidly, there is a higher loss of bean solids, and the resultant product differs from the first. Above 95° F. bacterial development takes place and at the end of eight hours there is frequently evidence of souring even though the water be changed two or three times. The effect of using 160°, 200°, or other high temperature is to shorten the time for plumping but many persons consider the product not equal to that obtained by soaking in cold water. When beans are subjected to 200° to 212° for an hour, some of them split, and when for two hours or more many split, soften, lose soluble solids and starch, turn pinkish and change in flavor. No bacterial changes occur at these temperatures or other above 160° F.

In order to obtain prompt and uniform absorption in beans grown under dry conditions, it is only necessary to give them a bath in hot water at about 170° for one minute or 150° for two or three minutes to soften the surface. A longer exposure will do no harm, and the treatment can be given easily in a continuous type of blancher. Without this precaution some beans may remain hard through an ordinary soaking process and a small percentage resist the action of cold water for 24 hours or more.

The rate of plumping varies with beans from different varieties, and with the initial moisture content. In general they start slowly, increase rapidly for a time, and then the rate is retarded as it approaches the maximum. If the water be cold, there is comparatively little loss from the bean, but if hot, there is loss in soluble solids, amounting to more from a few minutes of parboiling than from a whole day’s soaking in cold water. The water used should preferably be soft and changed about every three hours or at the outside every four hours. The treatment with cold water as indicated produces the minimum change in the bean other than the absorption of water, gives a uniform condition for the softening in the subsequent heat treatment, permits of the even filling of the cans with almost no adjustment for subsequent change in the can, and finally permits wider latitude in the time of handling in the factory than does warm or hot water treatment. Furthermore, the final product has a better bean flavor.

The soaked bean should be plump, white with a faint cream color, and with an effect of semi-translucency. The skin should be intact, and the odor free from sourness.

There are many factory methods based upon the soaking in warm or hot water in order to shorten the time of operation. These vary from soaking for about four hours at 120° F., with the water renewed and heated to from 185° to 200° F. for an hour or more depending upon the condition
of the beans; or they may be heated gradually to boiling and held at that
temperature for about an hour and a half. The beans are filled into the cans
and the weight adjusted with reference to the sauce so as to get the proper
cut-out. There are many variations of this kind which have to be worked
out by the individual packer according to his equipment. One method is
to place the cleaned beans in the can in the proper quantity and add a very
thin sauce. They are then heated to about 185° to 190° for two hours to
cause plumping during which they take up the water from the sauce and
are then given the usual cooking temperature for sterilizing. This elimi-
nates all soaking tanks, shortens the time and saves labor.

One is frequently advised to use a small quantity of bicarbonate of soda
in the first soaking water in order to soften the waxy surface of the bean
and then to depend upon subsequent washing to remove the soda. The
amount of soda is about one pound to each 25 gallons of water. This is
well in the case of beans which have been slightly frost bitten or have a
slightly sour odor upon heating, but is of doubtful benefit with strictly
prime beans. It always causes some deepening of color and produces flat-
ness in flavor. On general principles, it is best to use soft water in the
soaking.

The table shows the rate and volume of water absorbed by the principal
canning varieties of beans and some other legumes.

The chart shows the rate of absorption in white beans at various tempera-
tures. Other varieties were tested in the same way and, in general, the
behavior was similar.

**EFFECT OF SOAKING ON VARIOUS LEGUMES. (65° F.)**

100 Grams of Legume Used. The Increase in Weight Represents
the Amount of Water Absorbed.

<table>
<thead>
<tr>
<th>Large White</th>
<th>Small White</th>
<th>Manchu-rian</th>
<th>Lima</th>
<th>Kidney</th>
<th>Red Mexican</th>
<th>Cran-</th>
<th>Berry</th>
<th>Lentil</th>
<th>Pinto</th>
<th>Gar-banzos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>1 hour</td>
<td>1080</td>
<td>1080</td>
<td>1100</td>
<td>1040</td>
<td>1020</td>
<td>1160</td>
<td>1140</td>
<td>1060</td>
<td>1200</td>
<td>1120</td>
</tr>
<tr>
<td>2</td>
<td>1300</td>
<td>1120</td>
<td>1360</td>
<td>1140</td>
<td>1220</td>
<td>1280</td>
<td>1060</td>
<td>1400</td>
<td>1260</td>
<td>1400</td>
</tr>
<tr>
<td>3</td>
<td>1480</td>
<td>1200</td>
<td>1480</td>
<td>1400</td>
<td>1480</td>
<td>1380</td>
<td>1060</td>
<td>1360</td>
<td>1340</td>
<td>1560</td>
</tr>
<tr>
<td>4</td>
<td>1700</td>
<td>1480</td>
<td>1640</td>
<td>1450</td>
<td>1660</td>
<td>1520</td>
<td>1090</td>
<td>1680</td>
<td>1440</td>
<td>1700</td>
</tr>
<tr>
<td>5</td>
<td>1780</td>
<td>1630</td>
<td>1700</td>
<td>1500</td>
<td>1740</td>
<td>1640</td>
<td>1100</td>
<td>1800</td>
<td>1600</td>
<td>1820</td>
</tr>
<tr>
<td>6</td>
<td>1880</td>
<td>1740</td>
<td>1780</td>
<td>1600</td>
<td>1820</td>
<td>1740</td>
<td>1140</td>
<td>1920</td>
<td>1680</td>
<td>1880</td>
</tr>
<tr>
<td>7</td>
<td>1940</td>
<td>1840</td>
<td>1840</td>
<td>1860</td>
<td>1840</td>
<td>1820</td>
<td>1180</td>
<td>2000</td>
<td>1820</td>
<td>1960</td>
</tr>
<tr>
<td>8</td>
<td>1970</td>
<td>1880</td>
<td>1940</td>
<td>1880</td>
<td>1940</td>
<td>1880</td>
<td>1200</td>
<td>2000</td>
<td>1820</td>
<td>2060</td>
</tr>
<tr>
<td>10</td>
<td>2040</td>
<td>1940</td>
<td>1880</td>
<td>2020</td>
<td>1920</td>
<td>1980</td>
<td>1300</td>
<td>2020</td>
<td>2040</td>
<td>2120</td>
</tr>
<tr>
<td>11</td>
<td>2050</td>
<td>1960</td>
<td>2030</td>
<td>1950</td>
<td>1360</td>
<td>2020</td>
<td>2160</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2060</td>
<td>1980</td>
<td>1920</td>
<td>2030</td>
<td>1970</td>
<td>2000</td>
<td>1500</td>
<td>2270</td>
<td>2160</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>2100</td>
<td>2040</td>
<td>1960</td>
<td>2070</td>
<td>1980</td>
<td>2040</td>
<td>1920</td>
<td>2120</td>
<td>2440</td>
<td>2220</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2040</td>
</tr>
</tbody>
</table>

**Soaking Tanks**

The soaking may be done in any kind of tank but wood is undesirable as
the pores become saturated with organisms and the long soaking periods
are favorable for their development in large numbers thus adding infec-
tion to the beans, and further, it is easily conceivable that the organisms
developed by many generations under such conditions might acquire a high
degree of heat resistance. Galvanized iron is used most, has the advantage
of being light, and may be made in sizes that can be trucked readily about
the factory, an advantage not to be considered lightly when canning in large volume. Such tanks are much more easily cleaned than wood and can be sterilized with steam. The finest tank, however, is glass-lined, and while rather expensive, it should be considered in a permanent installation. They are easily cleaned and sterilized and there can be no contamination from metal. The depth of the tanks is not very important, from 2 to 5 feet, the preference being for those under 3.5 feet. Since the process of taking up water is one of endosmosis, the slight variation in pressure due to the column of water has little effect. The tanks are usually filled about one-third full of beans.
Blanching

At the conclusion of the soaking period, the beans are blanched for varying periods, from a mere hot water wash to a parboil of a half-hour or more. If the soaking has gone to the point of practically full plumping, there seems to be nothing gained, but much lost, from a prolonged heating. A heating of about four minutes suffices to carry off the peculiar raw bean flavor that is noticeable and sometimes unpleasant in improperly prepared beans. The softening may be obtained by prolonging the time of cooking in the cans and without loss of any constituents. Beans plumped by hot water treatment receive all the precooking that is needed.

Alternative Treatments

Three courses are open in the canning: first, to fill the cans with beans, sauce, and pork, seal and cook; second, to deliver the beans into shallow pans for baking either in a gas oven or in a steam heated oven; and third, to partially fill the cans as in the first instance but to run the unsealed cans on a conveyor through an oven at about 450° F. for from 15 to 20 minutes, then to add sauce and seal. This last method is a new development covered by a patent No. 1,718,187, June 18, 1929, issued to G. M. Bartlett, Merchantville, New Jersey.

Baking in steam and baking by a continuous method in a gas oven were the inventions of the H. J. Heinz Co. A modified form of gas-oven baking was invented by F. O. Libby, Portland, Maine, upon which he received patent No. 1,548,796, August 4, 1925. Parts of the text of that patent and of No. 1,718,187 are added as an appendix.

If the beans be packed directly from the blancher into the cans, they become beans with pork, beans with sauce, beans vegetarian style, etc., but not baked beans. Baking implies precooking the beans to produce an effect similar to those prepared in home baking. Just what methods may be used has been open to controversy. The Bureau of Chemistry has not issued a Service and Regulatory Announcement covering the use of the term "baked" on the label but has advised "inquirers through correspondence that the term in connection with beans is applicable only when the true process of baking has been used. In our opinion, the term 'baked beans' is permissible only in connection with beans which have undergone their entire cooking process in open or loosely covered containers in dry-heated ovens. If the finished product is put on the market in cans instead of earthenware pots, the usual retorting of the article after sealing in the can should constitute merely the sterilization of an already completely baked article."

Fortunately the terminology used on the label whether "baked beans," "pork and beans," etc., is not nearly as important as either the manufacturers or food officials assume. The former have been desirous of capitalizing upon the sales value of "baked" due to the reputation of the New England product while the latter are concerned with the technicalities of the method of cooking rather than the character of the final product. What some consumers are interested in is prepared beans which closely approach the baked bean, but supplied in cans, which at present they must learn to select by the name of the packer rather than by any statement on the label.

If one take the trouble to look up the use of the term "bake" in culinary works, it will be found that it has been and is used in a very broad sense
for heating or cooking in an oven even though the foods be dissimilar in character and the results not strictly comparable. It is usually applied to cooking in dry heat which is more or less confined, ranging from such high temperatures as produce the effect of roasting to barely enough to cause the drying of delicate herbs. The brick or earthen oven is one of the oldest devices for cooking and often the most convenient for heating any food product which might be at hand. The heavy walls were heated by fire directly or in the more advanced type from a fireplace. The heat was naturally dry but might be augmented by basting or in other cases by placing a vessel of water in the oven to supply moisture through evaporation. An examination of a score of recent cook books will show an equally versatile use for oven cookery though the devices have been greatly improved and subject to complete control. The term was also used for foods cooked under hot ashes and coals or on bake stones. In the famous shore clam-bakes, stones are laid down and a hot fire built over them to be sure that they are well heated, then cleaned of ashes, the clams laid down and covered with seaweed to hold the heat. The pioneer woodsman made his variation by digging a shallow hole by the side of a stump, building a hot fire to burn the stump and heat the surrounding ground, then set or hung his pot in the hole, covering the same with a slab. The cooking might go on for several hours or over night or be simply used for reheating.

Theoretically, baking is a form of cooking by conduction with dry heat as distinguished from roasting or cooking by radiant heat. Naturally the two types of heating often overlap as expressed in oven roasting. Practically the cooks do not make such fine distinctions. One finds also that the term "baked" was applied most often to dough products as bread, cakes, and pastry, to cuts of meat, small animals, poultry, fish, some kinds of vegetables and fruits, all of the kind of product which have moisture incorporated in their structure or tissues rather than as free as in the case of beans. The first important exception to this use of baked was for meat pies in which case the meat mixture was partly prepared before being placed in the crust and heated in the oven. Other variations naturally followed. Custards, puddings, and other dishes having free water but heated under the same conditions may or may not be called baked. In home canning in an oven the fruits and vegetables receive identically the same kind of heating as do the beans but no one thinks of them as baked.

The highly inefficient means of heat conduction by dry air has a distinct advantage for the preparation of certain foods and under certain conditions since the temperature in the food substance does not rise above 212° even though the oven may be at 250° or 400°. This was particularly true when baked beans originated as people had to depend upon heavy ovens and wood for fuel. The heating was far more regular in action and much less trouble than cooking in a pot over an open fire.

The New England type of baked beans is the result of slow moderate cooking of the ordinary white bean. The soaked beans with sauce and pork are placed in a container and heated for several hours to break down the cellular tissues and starches and to cause them to combine with the other ingredients to make a palatable food. The earthenware pot was only an incident to the process though advantageous because of the slow heat penetration. It was a necessity at one time the same as the iron skillet of the
past generation because aluminum was unknown. The beans never go above 212° or at the outside 214° except the surface layer or when there is much loss of moisture without the usual replenishment. The effect on the bean is the same as cooking at or near boiling with the oven affording the most convenient method of applying the heat. Except where gas and electricity are available, a low fire requires constant attention and allowing a flame to strike the bottom of the pot produces ebullition of large bubbles which break at the surface and carry away moisture, and as a consequence require more frequent replacement. The combination of a liberal amount of fat pork and old-fashioned molasses is also a factor in checking free evaporation as well as imparting a color to the oven-cooked beans that is usually absent in plain boiled beans.

An experiment made by dividing soaked beans into two lots using the identical quantities and the same sauce, one cooked in an aluminum pot over a low fire, the other in a pyrex dish in an oven, each heated to 207° to 212° for eight hours, were scarcely distinguishable. Those over the fire had a few more broken skins and slightly softer. There was no difference in flavor.

Evolution in cookery has demonstrated that certain effects can be obtained by raising the temperature which will shorten the time needed for cooking. An effect similar to holding beans near the boiling point for several hours can be obtained by raising the temperature to 245° to 250° for an hour provided the beans be kept in relatively thin layers and subjected to the direct action of steam in a retort with the vent open. Under these conditions the beans are cooked through with a loss of moisture corresponding with that in baking bread, meats, and vegetables. By combining the proper proportion of such beans, pork, and the same kind of sauce as used in the home preparation one obtains a very close approximation to the so-called baked beans, closer than most canned products do to the table preparations. One may add that any system of cooking which does not raise the temperature above 212° will not cause the beans to undergo "their entire cooking process" in a short time.

Steam cooking in the retort is not looked upon as complying with the definition for baking in the strict technical sense, and to meet the objection raised, jacketed retorts have been constructed but called ovens. Steam is admitted to the jacket to provide the desired degree of heat but not to the food chamber. The soaked beans are spread in thin layers on pans, placed in racks and slipped into the retorts. The retort is closed and the heat from the jacket soon generates sufficient steam within the chamber to cook the beans in the same manner as in the regular retort and with the same result.

Baking in a gas oven is also carried out as a continuous process. The beans are filled into pans and carried through on a conveyor.

Beans which have been precooked in an oven are generally drier and mealier than the boiled beans and the flavor is different. In filling the cans the pork is deposited first, followed by the beans and then the sauce.

Pork

The pork needs to be of the best quality salt pork, sides or bellies, with a good streak of lean, and be well cured. No greater mistake can be made than to assume that any salt pork will do. It is this ingredient that imparts flavor and smoothness to the sauce through rendering some of its fat in
the cooking, and if it be old or off-flavor for any reason, it imparts that quality to the whole, for in the sealed can nothing escapes. While the bean is rich in food value, its palatability is enhanced by the addition of the fat.

The pork is kept dry and cold up to the time of cutting, then it is cleared of surplus crusts of salt, washed, and the slabs cut into strips so that when cut across in slices about one-half inch thick, they have practically the correct weight for the individual can. This work can be done best by hand in order to utilize the pieces advantageously. Machines cut to a definite width and thickness, but hand cutting can be varied in accordance with the piece of pork.

The size of the piece of pork was first based upon a liberal allowance, or one ounce for a No. 3 can, the smaller cans being given the same proportion but a lesser quantity for the No. 10 can. The schedule is as follows: No. 1 can, \( \frac{3}{4} \) ounce; No. 2 can, \( \frac{3}{4} \) ounce; No. 2\( \frac{1}{2} \) can, \( \frac{3}{4} \) ounce; No. 3 can, 1 ounce; and No. 10 can, 3 ounces.

The piece of pork is dropped into the bottom of the can by hand before it goes to the filling machine. No machine has been developed for doing this part of the work but there are several available for adding the beans and the sauce in separate operations and in the proportions desired.

**Sauce**

The formulae for sauces are numerous and vary considerably, especially in the proportions of the constituents. Basically, they consist of water; salt; sugar as refined or brown, or molasses; spices; and in one type tomato takes the place of part of the water. They can all be grouped into two classes, plain sauce and tomato sauce. The early sauces were all plain sauces, composed of water, salt, molasses or brown sugar, and spices, of which mustard was the most prominent, the others being pepper, cinnamon, cloves, allspice, and mace. These were used sparingly, only enough to suggest spicing but not sufficient for the recognition of any one. Molasses and brown sugar were staples at the time and have been continued in most recipes to impart color and flavor. Refined or granulated sugar produces sweetness without a tang and leaves the bean white. Starch, vinegar, onions, and garlic are comparatively recent additions to the culinary repertoire.

The following is a fairly representative formula for a plain sauce: water 100 pounds (12 gallons); salt from 2 to 2.5 pounds; sugar, from 6 to 8 pounds which may be in the form of brown sugar or molasses, two parts of molasses being considered equal to one of refined sugar; and spicing in kind and quantity to suit the taste. These ingredients are boiled together, skimmed, and added to the beans while hot. If the beans be well plumped and the fill of the cans adjusted carefully to get a full can, no thickener will be required.

A good tomato sauce for beans is a mild ketchup added at the time the beans are served. The flavor of both beans and sauce are at their best. The tomato is injured by the long, high temperature necessary to cook the beans when the two are combined in the canning, but even with that handicap, beans with tomato sauce are so much more popular than in plain sauce that the latter are not carried in many places.

A heavy tomato sauce is prepared in the same way as a mild but high grade ketchup with the modification that no vinegar is added and some
cutting is done in the quantity of sugar. This gives the maximum of tomato flavor. The time required for the evaporation of the tomato juice is sufficient for a good extraction of spices and of the onions and garlic. The evaporation of the juice is carried to a specific gravity of 1.035 or more. Sugar added to the amount of 16 per cent, and salt equivalent to 3 per cent. Since the product is sterilized and not exposed after opening, it does not require the same degree of concentration nor the high percentage of sugar as table ketchup. This sauce can be diluted as much as 10 times, the amount of dilution depending upon the proportion wanted in the bean. In the higher dilutions, some additional salt is required.

Some packers prefer to use canned pulp of a 1.033 specific gravity and add the desired amount of water, sugar, salt, and spices, including onion and garlic, and make their sauce at the time it is wanted. The tomato in the dilution may be from 1 part to 1 part of water or as high as 1 part to 8 parts of water. The salt is made about 2 per cent of the finished product and the sugar about 8 per cent. The amount of dilution is made to depend upon the quantity of sauce which will be taken up by the beans in the can, also upon the character of the sauce wanted in the final product. As with plain sauce, no starch is needed when the fill of beans and sauce are well adjusted and the dilution of the tomato has not been carried to excess. Brown sugar or molasses are not used generally in tomato sauce for canned beans as they impart a poor color to the tomato.

There are plenty of formulae available for both plain and tomato sauces but it is much better to use the fundamentals as a basis for experiments and make variations in accordance with one's own conditions and tastes. The mathematics of the procedure can be obtained from Bulletin No. 15, National Canners Association (1918), "Suggestions for Canning Pork and Beans," by W. D. Bigelow and F. F. Fitzgerald.

A particularly fine sauce, made several years ago, had the following composition: Whole tomato pulp, 28 gallons; water, 50 gallons; New Orleans molasses, 2½ gallons. Cook for 5 minutes, then add 38 pounds granulated sugar; 1½ ounces capsicum; 7¼ ounces cinnamon; 17 pounds of salt; and 9 pounds of the best grade of butter, and heat for 15 minutes.

Fill of Cans

The fill of the can is dependent upon the preliminary preparation of the beans and the character of the product desired. In some experimental work, 20 ounces of beans, 1 ounce of pork, and 15 ounces of sauce gave an almost ideal fill for a No. 3 can, but in commercial preparation, few packers used that quantity of beans. Some formulae for quickly plumped beans call for as low as 15.5 ounces, but in such cases the beans are not fully plumped and take up moisture in the cooking, or the final product will contain an excess of sauce. However, the proportion of split or broken beans in the final product is always increased with a liberal quantity of sauce.

A good exhaust is desirable so as to have the cans well heated before going into the retort. It decreases the strain on the cans incident to the long cooking.

Cook

Heat penetration in beans is naturally a variable quantity, reasonably rapid in those having an excess of thin sauce and slow in those with little
free moisture or of a heavy consistency. Beans with a plain sauce can stand a higher temperature than one with tomato sauce, while the added acidity due to the latter is assumed to aid in the sterilization. In either case, however, the cooking required to make the beans thoroughly tender is greater than that needed for sterilization. A temperature of 250° F. may be used on beans having a plain sauce but it is not advisable to go above 240° when tomato sauce is used as anything above that temperature is almost certain to cause injury to the color and to develop some bitterness in the flavor.

If the beans have sufficient sauce to produce a moist product and with little free liquid, the cooking should be about as follows: at 240° F. No. 1 can, 70 minutes; No. 2, 90 minutes; No. 2½, 105 minutes; and No. 3, 120 minutes. If the pack be dry or is steam baked for one hour at 245°, the schedule will need to be increased: at 240° F. No. 1, 75 minutes; No. 2, 95 minutes; and No. 2½, 120 minutes. The long time required for the No. 10 can makes its use undesirable as the beans are injured in quality. If used at all, the beans should be moist or even sloppy. It is preferable to use a larger number of No. 2½ cans than the No. 10. Some packers shorten the time of cooking by raising the temperature of the retort at the start to 250°, hold it for 15 minutes in order to get a more rapid heat penetration to the center, then drop back to 240°.

For oven baked beans the schedule given by the National Canners Association is No. 1, 70 minutes; No. 2, 95 minutes; No. 2½, 115 minutes; No. 3, 120 minutes; and No. 10, 225 minutes.

Beans are not cooked in an agitating cooker, particularly those with tomato sauce, as it results in a curdled appearance in the sauce.

**Label Weights**

Beans and pork (Sp. Gr. 1.08): 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

**S. R. A. No. 1. The Use of “Cull” Beans**

The attention of the Board of Food and Drug Inspection has been called to the practice of using “cull” or other beans which are mouldy, musty, or otherwise decomposed in various canned food products, such as baked beans or pork and beans. Products made from such material are manifestly contrary to section 7, paragraph 6, in the case of foods, of the foods and drugs act.

The use of tomato sauce or pulp which is prepared from decomposed tomato or trimming stock, in the preparation of baked beans or other food products with tomato sauce, is also deemed to be in violation of the law.

**Process Patents**

Patent No. 1,548,796, issued August 4, 1925, to Francis O. Libby, Portland, Maine, contains the following:

My present invention involves the cooking of legumes and particularly those beans which are prepared for human consumption in certain forms known as baked beans. My invention is of particular importance in the preparation of canned baked beans, although applicable to domestic as well as to commercial cooking of the same.

The value of the bean, of which there are many varieties adapted for human consumption, has been long recognized, and beans have been long a staple article of human diet. The difficulties of properly cooking beans have long been appreciated, but in spite of the fact that the bean could be more digestibly prepared in other ways, there has
been a marked preference in most civilized countries for beans cooked so as to pre-
serve their natural form, as against ground beans or stewed beans or beans prepared
by other methods, in which the form was wholly or partly lost. This preference or
rather demand has imposed difficulties, especially on those preparing beans commer-
cially, as where such beans are canned.

It has long been known that beans contain much indigestible matter. Of these there
are the cellulose and part of the starches. The former is not directly useful for food
purposes, but the latter is potentially valuable but difficult of reduction to a form for
assimilation. In addition to this is the presence of the fibrin which is the important
asset of the legumin.

It has been pointed out that the skin of the bean contains a large percentage of
undesirable cellulose. In this there is another factor somewhat related but which does
not seem to have been recognized or its importance realized. The so-called skin of the
bean is an envelope of considerable strength designed by nature to have a resistant
protective relation to the interior. In its natural state the skin may be considered as
in effect a dialyzing membrane, permeable by water and salts, but not permeable by
colloidal or like matter.

In the preparation of baked beans as ordinarily carried out, there is a preliminary
soaking and usually parboiling of the beans. After the beans have been so treated
the interior is more or less saturated. After the bean is in this condition, in which it
is somewhat softened but otherwise substantially unaffected, it is usually cooked in
a seasoned liquor intended to impart flavor to the bean while its preparation is being
completed.

The cooking changes sought to be accomplished involve a desired change in the
starch or portions of it to render it digestible and for this purpose the treatment of the
starch by hot water is very important as the starch is not readily affected except by
hot water or steam. The bean, even when previously saturated or softened by par-
boiling, has always been resistant and difficult to cook and particularly slow to take
on the desired flavor.

I have discovered that it is possible to simplify the skin membrane so as to make it
more readily permeable to cooking juices. Furthermore, I find it possible to cause the
bean to absorb these juices more readily than where they were introduced at this stage
of the cooking immediately after parboiling, and while substantially saturated.

I effect this double desideratum by a single simple step which I will now proceed
to explain, making reference for the purposes of illustration, to a process adapted for
producing canned baked beans, although it will be understood that the step may be
used in any process for such a cooking.

It is obviously extremely difficult to ascribe an exact theory to such changes as I
will now describe, but I will endeavor to interpret my invention by an explanation of
a theory which seems to be justified from the results as actually observed.

After the beans have been thoroughly saturated by parboiling, I expose them for a
short time to the direct influence of an intense heat. In practice, I pass the beans as a
thin layer directly beneath gas burners at temperatures between 350° and 500°, depend-
ing on the character of the beans. This intense direct heat seems to change the char-
acter of the skin from what may be called a dialyzing membrane to a simple membrane.
In practice, this change should be only partially effected because if carried beyond a
certain point, the beans become mushy and lose form so as not to be acceptable to the
public. In practice, I find that for canning purposes, where the beans are to be proc-
essed in a flavoring liquor, that about three minutes exposure to heat, as above de-
scribed, sufficiently changes the skin so that the juices can pass through it.

At the same time, by this dry baking I produce another effect which affords a valu-
able combination with the first result. As before explained, when the beans are intro-
duced into the cooking liquor in their saturated state, there is very little tendency of
the bean to absorb the liquor, and the interchange of the flavoring elements of the
liquor is very reluctantly effected in the bean. This was one of the reasons for the
common supposition that beans, in order to be properly cooked and flavored, must be
cooked for a very long time.

During my preliminary dry baking, during which the skin membrane is modified. I
also drive off from the softened bean considerable of its water of saturation. When
so prepared, they may be introduced into the cooking liquor, so that the bean has an
immediate tendency to absorb the juices which effect is now possible whether they be
flavorings, fats or other elements, because the bean skin is now apparently rendered
colloidally permeable.
The time of dry baking varies somewhat with different kinds of beans. For the so-called Japanese beans, a temperature of about 400° and an exposure of 400° about three minutes seems most efficient for the initial cooking, after which the beans can be processed in the cans with the cooking liquor in about two hours, at a temperature of 240° F., but care must be exercised not to over-process.

Baked beans prepared in accordance with my invention, even where put through in large quantities, as for example, in five ton lots, can be produced with the greatest perfection of flavor and in more digestible condition.

The initial dry baking appears to render the cellulose and particularly the extremely indigestible cellulose of the skin so that it is entirely digestible and the subsequent permeability of the bean, by reason of the changes in the skin, makes it possible to secure a high degree of conversion of the indigestible starch to digestible starch.

This permits the digestion of the starch in the stomach, and so relieves the burden on the digestive action of the intestines upon which depend the proper digestion and assimilation of the fibrin, which is the important factor which makes the bean so valuable as a substitute for meat.

My invention is capable of practice in a variety of ways and with a variety of apparatus, most of which is available as present equipment in canning factories. My oven for dry baking may be of any type, from the most simple to more complicated devices where speed and quantity are important factors.

Bartlett Patent

Patent No. 1,718,187, issued June 18, 1929, to George M. Bartlett, Merchantville, New Jersey, makes the following contribution:

Under the ruling of the Board of Food and Drug Inspection, beans packaged and labeled as "baked beans" must be baked in open containers in the presence of dry hot air. To meet these requirements, those canning baked beans have usually baked the beans in a batch in a large crock or pot, and after the baking has been completed, they have transferred the beans, so baked, into the cans and then sealed the cans.

But the transference of soft baked beans from a crock or pot to a can invariably entails the breaking of the skins of some of the beans and mashing of others, with the result that too much sauce enters the broken beans, making those beans soft and mushy. Moreover, some of the pulp of the beans separates from the beans and mixes with the sauce, thickening the sauce and making the sauce turbid. This is very undesirable as it injures the appearance of the product and makes uniformity of product impossible. The difference in the number of beans broken in different cans and the length of time the cans are kept before use will cause the contents of the cans, even when filled with beans of the same batch, to differ greatly in appearance, taste and quality.

It must be appreciated that uniformity of a product in tins is one of the most important ends to be attained in the canning industry. A purchaser of canned goods expects every can of a given line and packaged by a given packer, to be exactly like every other can which he has previously purchased of that particular brand and if the contents of one can of beans be soft and with a thick sauce and another can have fewer broken beans and consequently thinner sauce, and if the cans differ substantially as to color, taste and substance, that line of goods will be avoided by the trade in favor of the goods put up by another canner, the contents of whose tins have been found to be uniform in condition of pack, appearance and taste.

It is practically impossible to transfer baked beans to cans and at the same time preserve all of the beans intact and unbroken, and a small variation in the number of broken beans will greatly vary the appearance and quality of the pack.

With these considerations in mind, an object of the present invention is to produce canned baked beans of the best quality free from broken beans and with a uniform sauce, unmixed with the pulp of crushed beans, the contents being of superior appearance and uniformly of the very best quality.

A further object of my invention is to produce a canned baked bean product without making it necessary to transfer the beans, after cooking, into cans, or to subject the beans to any handling or treatment whereby the cans are agitated and the contents are broken, thereby eliminating the liability of producing cans of beans which are mashed and discolored and seasoned with a thick sauce.

A further object of my invention is to bake the beans in the very cans or tins in which they are to be later hermetically sealed and placed on the market.
A further object of my invention is to provide a method of baking beans in a shorter time than that usually required for the production of baked beans with a consequent reduction in the cost of production, and to effect uniformity or standardization in the product.

In carrying out my improved process, I use only the best hand-picked beans containing not more than one and one-half per cent spot or blemish. The entire quantity of beans to be baked is first soaked in cold water for about ten hours.

After soaking in cold water has been completed, the beans are carefully picked over and those beans which are not water-absorptive, those beans having defects, such as black spots, which are generally more easily observed in the soaked swollen beans than in dry beans, and any broken beans are removed. The remaining beans are now in a substantially perfect condition, unbroken, of substantially the same size and containing the same amount of water, absorbed by the beans during the water soaking step.

The beans are next blanched (parboiled) but without breaking the skins. This parboiling is preferably carried to a point where the skins or hulls of the beans would break if punctured with a pin.

These substantially perfect parboiled beans now are placed in the cans or tins in which the beans are to be marketed, together with a piece of pork of the correct weight for the quantity of beans in the can. Each can is thus filled with beans to about 80 per cent of the full capacity of the can.

At this step, the seasoning and flavoring ingredients, mixed with water and called the “sauce,” are placed in the cans, the level of the sauce being a little above the level of the beans.

For convenience, a normal sauce for the beans may be assumed to be an aqueous sauce of 100 units concentration. That is the convenient way for designating the strength of a normal aqueous sauce. A sauce of 150 units concentration would have 1.5 times the weight of ingredients (other than water) that an equal volume of a 100 unit concentration sauce would have. The mode of treatment with different sauces will be referred to again below.

The open cans, so filled with beans, pork and sauce, are preferably placed on a carrier of any suitable style and slowly passed through the oven. The time when the cans or tins are placed on the carriers is immaterial, for the carrier which conveys the tins through the oven is preferably the same carrier that conveys the tins under the can filling machines and to the sealing machines, in which case the carrier would pass directly from the filling machines through the oven, to the sealing machines.

The temperature of the oven is preferably between 400° and 500° F. and preferably at or about 450° F. and the beans are subjected to the high heat of the oven for a time sufficient to substantially bake the beans in the open cans.

But because the oven is relatively hot, and because the quantity in each can is relatively small, as compared with the contents of a large bean pot, the beans are almost immediately brought to a relatively high cooking temperature, with the result that the baking is completed in considerably less time than that required to cook beans at the relatively low temperatures employed in the baking of beans in the home.

Upon the removal of the tins from the oven, a quantity of water is added to each can sufficient to compensate for the water lost by evaporation during the baking step and to dilute the sauce in the can to the normal strength or concentration of 100 units and if desired an additional amount of normal or concentrated sauce may be added at this point to impart to the beans the particular flavor that may be desired. The cans are next hermetically sealed, while hot, and are then processed or sterilized for about one and a quarter hours at a temperature of substantially 250° F. The cans are then transferred to the labeling machine in which a label is wrapped around each tin.

The sauce added to the beans may be of different concentrations. Thus the sauce which is placed in the tins before the baking step may be of 100 units concentration, a normal sauce. When that sauce is used in the process, the sauce becomes more concentrated during the baking step by the evaporation of the water and the water added to the cans after the baking operation or step will be merely sufficient to bring the concentration back to 100 units. Only enough water need be added to compensate for the water evaporated during the baking step and that amount of water will dilute the sauce to normal concentration.

It is preferable, however, to use a sauce of a higher concentration, as for instance, a sauce of up to 150 units concentration, because a concentrated sauce tends to penetrate more deeply into the beans and to impart to the beans a more desirable color.
After baking the beans with a sauce of higher concentration than normal, the amount of water which is added is that which would be required to compensate for the evaporation plus enough more water to dilute the higher concentration of sauce down to a normal 100 unit concentration.

In some cases, the beans may be baked with only a part of the ingredients of the sauce and with the pork, the sauce being substantially water. When the invention is so practised, and the baking has been completed, water may be added, if desired, sufficient to make up for the loss in the evaporation and then a sauce of any desired concentration (preferably a normal sauce) may be added to the baked beans.

I prefer, however, to follow the second example above given and to make the beans in a sauce of concentration higher than normal and to then dilute the sauce in the can of baked beans down to the normal concentration.

Throughout the treatment of the beans care is taken not to agitate the contents of the cans, for agitation tends to break some of the beans, and as above stated, broken beans in the can greatly affect the quality and appearance of the product.

It is to be observed that although the tins were not completely filled with blanched beans, the tins will be substantially full of baked beans after the baking step has been completed and the water or sauce or both water and sauce have been added, for the beans will continue to absorb water during the baking of the sauce, and will swell sufficiently to fill the can.

The process may be varied somewhat from the exact proportions and times above given by way of examples, without departing from the spirit and scope of my invention. In the preferred mode of carrying out my novel method of baking and canning beans, as above described, the baking in the oven is completed in fifteen or twenty minutes. The baking may be continued longer, however, e.g., up to one-half or three-quarters of an hour, provided the processing be effected at correspondingly low temperatures or for a shorter length of time, so as to avoid at the temperatures above given, any over-cooking of the sauce or beans.

**Lima Beans**

*Phaseolus lunatus*

The lima bean belongs to a different species from the common bean but, like the latter, is a native of the western hemisphere. It was found growing wild and also cultivated by the natives in the region of Lima, Peru, by the Spanish explorers. The seeds were sent to Spain at a later date than those of the common variety but did not meet with the same favor.

The plant presents the same general appearance and habits as the common bean and, as in the latter, there are two types, the tall growing, frequently referred to as the pole variety, and the bush or dwarf variety developed by horticulturists. A distinguishing feature is the large pods, about four to four and one-half inches in length, very broad and flat, containing about four large flat seeds. The pods are tough and not edible. The seeds are used both green and dry and possess a distinctive flavor which makes them sought after by those who appreciate delicacy and variety in their food.

The bush type of bean only is used by canners as it admits of easier cultivation than the climbing, and, moreover, the pods mature more nearly at the same time so that the vine may be harvested when the maximum number of small and medium beans are ready and the shelling be done in a pea viner. This eliminates the costly item of hand picking and shelling. The growing of the bean for canning when green was formerly done mostly by corn packers who packed succotash. These were located chiefly in New York, Michigan, and Maryland. The popularity of the vegetable has
grown so that it is packed as a special line, and succotash has become of secondary importance. The growing of the bean for its dry seed is confined to the southwest. In case the dry seed is to be used for canning, the vines are cut before the seeds ripen and are turned frequently to insure prompt drying. This results in a large proportion of the beans having a greenish appearance instead of the flat white or cream color and the flavor partakes more of that of the immature product.

Canning

Green lima beans for succotash or canning are harvested in the same manner as peas and are shelled in the viner operated at slow speed. Special screens or rubbers are used to permit the beans to pass through. The grading is done by passing them over screens having openings of 29, 30, 31, and 32 thirty-seconds of an inch. The smallest size is known as baby or tiny, the second size as fancy, the third size as medium, the fourth size as standard, and the fifth size as mammoth. The Nos. 1, 2, and 3 are used in fancy succotash, and the Nos. 4 and 5 in standard. The method of preparation for succotash is described under that subject. The green beans are packed according to size principally in No. 1 and 2 cans. Some packing is done in No. 10 cans as stock for soups.

The green lima beans are given a short blanch, filled into the cans with a one and one-half per cent brine, exhausted for four minutes and cooked at 240° F. for 35 minutes for the No. 1 and 40 minutes for the No. 2 cans. The National Canners Association recommends 45 minutes for both and 70 minutes for the No. 10.

Dry Lima Beans

The dry lima bean is soaked and used in succotash where dependence cannot be placed upon the corn and beans maturing at the same time. They are handled through the soaking in the same manner as the red kidney bean. They are also soaked and canned as a special product following essentially the same steps as for the red kidney bean. A plain brine may be used or one to which three per cent of sugar is added. The cook for both the No. 1 and No. 2 cans is 240° F. for 60 minutes.

In case the dry lima bean is used either in succotash or canned as a special item, that fact must be declared upon the label.

Label Weights

Green limas (Sp. Gr. 1.05): 8Z Short, 7¾ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

Standards

TENTATIVE UNITED STATES STANDARDS FOR GRADES OF CANNED LIMA BEANS

Definition

Canned lima beans are the canned vegetables prepared from the seed of varieties of the South American lima bean (Phaseolus lunatus) by shelling, thorough washing, with or without grading for size, precooking (blanching) and by the addition, before sterilization, of the necessary quantity of potable water, with or without salt, packed in hermetically sealed containers, and sterilized by heat.
GRADES OF CANNED LIMA BEANS

U. S. Grade A (Fancy) canned lima beans are prepared from fresh, young, tender, immature, green lima beans; are uniform in color; and conform to the size claimed for the beans. They are surrounded by practically clear liquor; do not contain in excess of 1 per cent by count of white lima beans; are practically free from skins, split beans (having cotyledons separated), broken beans (broken in two), and other defects; possess the distinct flavor of young fresh lima beans, and score not less than 90 points when scored according to the scoring system outlined herein.

U. S. Grade B (Extra Standard) canned lima beans are prepared from fresh, young, tender lima beans, of which not less than 50 per cent are green in color; and conform to the size claimed for the beans. They are surrounded by fairly clear liquor; are reasonably free from skins, split beans (having cotyledons separated), broken beans (broken in two), and other defects; possess a good fresh young lima bean flavor; and score not less than 75 points and need not score more than 89 points when scored according to the scoring system outlined herein.

U. S. Grade C (Standard) canned lima beans are prepared from fresh lima beans that may be white in color, either in whole or in part, and are surrounded by liquor which may be roily. The product is fairly free from skins, split beans (having cotyledons separated), broken beans (broken in two), discolored beans, and other defects; possesses a palatable lima bean flavor; and scores not less than 60 points and need not score more than 74 points when scored according to the scoring system outlined herein.

Off-Grade (Substandard) canned lima beans are canned lima beans that fail to meet the requirements of the foregoing grades, or when any one of the grading factors, with the exception of uniformity of size, falls in the subdivision D, or, canned lima beans that fall below any standard promulgated under the terms of section 8, paragraph 5, of the food and drugs act.

Note.—Certificates of grade issued under the United States Warehouse Act or the Farm Products Grading Law covering canned lima beans falling below any standard promulgated under the terms of section 8, paragraph 5, of the food and drugs act, must bear the legend required under that act in the space for “Remarks.”

PREREQUISITES TO GRADING

Condition of Container

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents and the ends shall be flat or concave.

Condition of Package and Label

If cased, the canned lima beans shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the food and drugs act.

Fill of Container

Cans of lima beans will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium (added liquid) is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned lima beans that do not meet the above requirements shall bear the legend,

“Below U. S. Standard”
“Slack Fill”

Relation of Lima Beans to Packing Medium

Added liquid is excessive in canned lima beans when the proportion of free liquid in the product is such that, when the contents of the container are poured out and poured back into the container standing on a level surface, and the lima beans leveled without downward pressure, the liquid completely covers the lima beans.

A certificate of grade covering canned lima beans in which the above condition is

1 Lima beans shall be deemed to be “Green” when the color is not lighter than “Chartreuse Yellow,” as illustrated in Ridgway's “Color Standards and Nomenclature.” “Chartreuse Yellow” may be described as yellowish pale green.

2 Beans of a shade lighter than “Chartreuse Yellow” will be considered to be “White” beans.
found, whether or not the head space is excessive, shall bear at least the 2-line legend, “Below U. S. Standard— Slack Fill.”

Drained Net Weight Requirements and Maximum Head Space Allowances

Drained net weights of lima beans are determined by emptying the contents of the can upon a circular sieve of proper diameter and containing 8 meshes to the inch (.097 inch perforations), and allowing to drain for two minutes. The sieve diameters used are: 8 inches for No. 2 size cans or smaller, and 12 inches for No. 2½ size cans or larger.

The minimum drained net weight and the maximum head space allowable in the sizes commonly used in packing lima beans are shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can size</th>
<th>Minimum drained net weight (in ounces)</th>
<th>Maximum head space allowable (measured from top of double seam in sixteenths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 (picnic)</td>
<td>7.0</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 1 tall</td>
<td>10.8</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 300</td>
<td>9.9</td>
<td>9.5</td>
</tr>
<tr>
<td>No. 303</td>
<td>11.0</td>
<td>9.4</td>
</tr>
<tr>
<td>No. 2</td>
<td>13.5</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 5</td>
<td>38.9</td>
<td>11.4</td>
</tr>
<tr>
<td>No. 10</td>
<td>72.0</td>
<td>13.6</td>
</tr>
</tbody>
</table>

ASCERTAINING THE GRADE

The grades of canned lima beans may be ascertained by considering, in addition to the foregoing requirements, the following factors: Character of Liquor, Absence of Defects, Uniformity of Size, Maturity, and Flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
<th>I. Character of Liquor..............................</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>II. Absence of Defects................................</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>III. Uniformity of Size................................</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>IV. Maturity...........................................</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>V. Flavor................................................</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Total...................................................</td>
<td>100</td>
</tr>
</tbody>
</table>

Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 13 to 15 means 13, 14, and 15.

I. CHARACTER OF LIQUOR

(A) To receive a rating within the highest group, 13 to 15 points, for this factor, the liquor surrounding the lima beans should be practically clear, and of thin water-like consistency.

(B) If the liquor shows a considerable quantity of starch particles in suspension, a credit of 11 to 12 points may be allowed.

(C) If the liquor is of a rather viscous, creamlike, starchy consistency, a credit of 8 to 10 points may be allowed.

(D) If the liquor is thick, murky or dark, and is excessively starchy, a credit within the range of 0 to 7 points may be allowed.

II. ABSENCE OF DEFECTS. The factor of absence of defects has reference to the degree of freedom from split, deformed, broken (broken in two), discolored beans, and other defects.

(A) Lima beans that are practically free from the defects mentioned may be given a credit of 14 to 15 points.

(B) If the product is reasonably free from defects, a credit of 11 to 13 points may be allowed.

(C) If the defects mentioned are noticeably present, a credit of 8 to 10 points may be allowed.

(D) Lima beans in which the defects are decidedly prominent shall receive a credit within the range of 0 to 7 points.
III. Uniformity of Size. When U. S. Grade A (Fancy) lima beans are graded for size, the following nomenclature relative to size is descriptive of the various sizes:

"Midget" size lima beans are green beans that will pass through a sieve containing 28/64 inch perforations and may be known as No. 1 size.

"Tiny" size lima beans are green beans that will pass through a sieve containing 30/64 inch perforations, but will not pass through a screen containing 28/64 inch perforations, and may be known as No. 2 size.

"Small" size lima beans are green beans that will pass through a sieve containing 34/64 inch perforations, but will not pass through a screen containing 30/64 inch perforations, and may be known as No. 3 size.

"Medium" size lima beans are green beans that will not pass through a sieve containing 34/64 inch perforations, and may be known as No. 4 size.

When two or more sizes are packed together, as for instance, where a canner elects to pack all beans that will pass through a sieve containing 30/64 inch perforations as his smallest size without attempting to remove the beans that will pass through a sieve containing 28/64 inch perforations, the certificate of grade for such beans shall indicate the correct sizes—that is, "Midget and Tiny Mixed," or "Sizes 1 and 2." If packed "Garden Run" or "Run of the Pod," the warehouse receipt or certificate of grade should so indicate.

(A) If the lima beans are practically uniform in size, and conform to the sizes claimed for the beans, a credit of 9 to 10 points may be allowed.

(B) If the lima beans are slightly lacking in uniformity of size, a credit of 6 to 8 points may be allowed.

(C) If the lima beans conform to the sizes claimed, a credit of 3 to 5 points may be allowed.

(D) If the lima beans are markedly irregular in size, a credit of 0 to 2 points may be allowed.

IV. Maturity. The factor of maturity refers to the character of the lima beans, their degree of immaturity or their approach to maturity. The higher scores for this factor may be given only for beans that are very tender, succulent and immature, the scale of scores descending as the beans approach maturity.

(A) To receive a rating within the highest group, 32 to 35 points, for this factor, the lima beans must be very immature and very tender.

(B) If the lima beans are tender, but somewhat more mature, a credit of 28 to 31 points may be allowed.

(C) If the lima beans are somewhat firm and mealy, but not hard, a credit of 25 to 27 points may be allowed.

(D) If the lima beans are practically mature or are hard, or sprouting is markedly noticeable, a credit within the range of 0 to 24 points may be allowed.

V. Flavor. The quality of flavor of canned lima beans and the liquor surrounding them shall be classified from the standpoint of palatability.

(A) If the lima beans possess a highly pleasing, distinct, young, fresh, lima bean flavor and aroma, a rating within the highest group, 22 to 25 points, may be allowed.

(B) If the lima beans possess a pleasant, fresh lima bean flavor and aroma, a credit of 19 to 21 points may be allowed.

(C) If the lima bean flavor is palatable, but lacking in the more desirable characteristics, a credit of 16 to 18 points may be allowed. Lima beans that fall in this classification shall not be graded above U. S. Grade C (Standard), regardless of the total score for the product.

(D) Lima beans that have an unpleasant or "off" flavor, and/or aroma, shall be given a credit within the range of 0 to 15 points.

Composition

The composition of the green lima bean as given by Wiley is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>68.46</td>
</tr>
<tr>
<td>Ash</td>
<td>1.69</td>
</tr>
<tr>
<td>Protein</td>
<td>7.15</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>1.71</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>20.30</td>
</tr>
<tr>
<td>Fat</td>
<td>.69</td>
</tr>
</tbody>
</table>

APPERTIZING 425
This shows the lima bean to have about three times the food value of the green pod bean.

Recent investigations have shown that the lima bean has an alkaline effect in the body which is considered especially valuable in cases of high blood pressure and is being recommended for persons having a tendency towards circulatory disturbances.


The term Lima, as applied to certain types of beans, is undoubtedly of geographic origin. As far as can be ascertained, the beans of the type known as Lima emanated from Lima, Peru, in South America, and this name is now applied very generally in the United States and in other English-speaking countries to cultivated edible varieties of the species *Phaseolus lunatus*. Foreign-grown beans of the species *Phaseolus vulgaris*, of which there are over a hundred varieties, have recently been imported under the name of Lima, qualified by such terms as Manchurian, Korean, and Japanese. A thorough examination of these beans has shown that they are not limas, but varieties of the common bean (*Phaseolus vulgaris*). The lima bean is considered superior to the common bean for table use, and for this reason importers, dealers, and canners are sometimes inclined to label common beans, chiefly the flat-seeded varieties, which resemble the lima beans in general appearance, as “Lima beans,” and to sell them as such at a price exceeding that of the common bean.

The investigations made in this bureau have yielded results which show that the varieties of the common bean can be easily distinguished from those of the true limas. Since the varieties of the lima type possess characteristics which can be relied upon in differentiating them from the varieties of the common type, importers, dealers, and canners should have little difficulty in identifying their beans and in labeling them correctly.

A report on this subject together with a table has been prepared, showing reliable characteristic differences between the more important varieties of the common bean and those of the small and large lima beans. It is expected that this will be published shortly.

Since lima beans are generally regarded as superior to common beans for table use, the latter should not be sold under the name of limas. The so-called Manchurian lima beans belong to the group of common beans and should not be labeled as lima beans, even though qualified by the name of the country of production.


The bureau recently has made an investigation of the amount of lima beans contained in cans of various sizes when the cans are packed to capacity without any resulting impairment of quality. It has been found that properly filled cans will, in general, yield at least the following drained weights of lima beans, the weight being determined in each instance by draining for two minutes on a \( \frac{3}{4} \)-inch mesh screen.

- No. 1: 2 and \( \frac{1}{4} \) by 4 inch sanitary: 10.0 ounces
- No. 2: 3 and \( \frac{1}{4} \) by 4 and \( \frac{1}{4} \) inch sanitary: 13.5 ounces
- No. 10: 6 and \( \frac{1}{4} \) by 7 inch sanitary (72.0 ounces): 4 pounds, 8.0 ounces

A can of a size not mentioned here should yield a drained weight of beans which bears the same relation to the drained weight indicated for the can nearest in size as that existing between the capacities of the cans in question. These weights refer only to the immature grades commonly known as “green” lima beans, and do not apply to “white” and “soaked” lima beans.

While the weights given in the preceding list represent in general properly filled cans, variation in the character of the beans may, in some cases, cause a variation from these weights. It is the bureau’s primary purpose, however, to secure the packing of a full can, and cans should in all cases contain the greatest amount of beans which it is possible to pack therein without impairment of quality, regardless of the exact drained weight obtained.

As a further index* it may be stated, a properly filled can should have a head space (measured from the bottom of the cover to the surface of the liquor) not greater than \( \frac{3}{8} \) inch in the case of No. 8 and No. 10 cans, and not greater than \( \frac{1}{4} \) inch in the

*The statements in this paragraph should be used also as an index of fill in the case of peas.
case of cans of smaller size, the amount of liquor being just sufficient to cover the beans. In the case of sanitary cans, the head spaces of \( \frac{3}{4} \) and \( \frac{1}{2} \) inch mentioned in the preceding list are practically equivalent to distances of \( \frac{1}{4} \) and \( \frac{1}{8} \) inch, measured from the top of the rim of the can to the surface of the liquor when the can is cut from the top.

In making declarations under the net weight requirements of the Federal Food and Drugs Act, the total weight of the contents of the can, liquid included, should be declared.


In the labeling of canned lima beans the term "green lima beans" should be reserved for fresh beans that are green in color. This term indicates not only the maturity the vegetable has attained but also its color. It should not be used if an appreciable quantity of white beans is present, even though the white beans be fresh.

Red Kidney Beans

The red kidney bean belongs to the same species as the common garden and white beans. There are three varieties grown for their mature seeds—the white, medium, and red. The last is the one most used for canning. The seeds are longer, broader, and flatter than the white or navy bean, and have different flavor. The plant is of the bush variety and grown as a regular field crop, harvested when the pods are ripe and the leaves fall. The principal growing sections are Michigan, New York, and California.

The red kidney bean is well described for color and shape by its name and in size it is from three-fourths to one inch in length. Although rather large it is not coarse. The flavor differs from both the pea bean and the lima bean.

Preparation

The dry beans are cleaned by machinery and hand picked for defects. Any which are spotted from anthracnose or other disease are discarded for stock feed. Since the dry beans are used, the packing is not seasonal but as needed to supply the market.

The beans are soaked in cold water for about 12 hours during which time the water is changed from 4 to 6 times. If the beans are old or have any bitterness, about a pound of bicarbonate of soda is added to each 50 gallons of water in the first soaking but not in that which is used later. The soda has another useful effect in causing the beans to swell more promptly and uniformly than if only plain water be used. The rate of swelling is about the same as for white beans in either cold or warm water but the latter is not recommended for it is liable to cause a pronounced flattish taste.

The well plumped beans are given a short blanch, about two minutes at about 200° F., as a long blanch is almost certain to produce splits. They are filled directly into the can and if fully plumped, the can is packed nearly full. If the beans are not fully plumped, allowance must be made for swelling during the cooking. The proper fill can be determined best by trial pack. A 2 to 2.5 per cent brine is added if a clear sauce be desired, and about a 3 per cent bean flour added if a thick sauce be preferred. The beans and brine are both filled into the cans hot so that no exhaust is necessary.
The cook which has been found by experience to be safe is 240° F. for 75 minutes for No. 2 cans and 90 minutes for No. 2½ cans. These are the two sizes most packed.

Label Weights

(Sp. Gr. 1.08). 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

California Pink Beans

The California pink bean is similar to the red kidney bean but smaller, the ends rather square, and the body less flattened. It is grown principally in California where it ranks second to the Lima, and also in other parts of the southwest. It is a good bean, ranking above the pinto in the market.

It is prepared in the same manner as the red kidney. Soaking is expedited by a warm water bath at about 160° F. for five minutes and then followed by cold water.

S. R. A. 201. California Pink Beans

The bureau understands that the type of beans known as pink beans or California pink beans differs from red beans and from kidney beans, and so it is considered that the use of the terms “red beans” or “kidney beans” would be misleading when applied to pink beans or California pink beans. Furthermore, in view of the definite commercial significance attached to the expression “kidney beans,” it is held that the word “kidney” should not appear upon the label of pink beans.

Pinto Beans

The pinto bean is a small, brownish, spotted bean long grown in the dry regions of Colorado, New Mexico, and Arizona, but not brought to general notice until during the war. It is rather plump or roundish and slightly larger than the small white bean.

It is packed in the same manner as the red kidney.

It is of good quality and is claimed to be more nutritious than other beans, having 1695 calories per pound compared with 1625 for the navy and 1605 for the lima.

Soy Bean

_Glycine Soja_

This is of a different species from our common bean, of tropical Asiatic origin, and with a number of varieties. It constitutes a very important part of the food of the Indians, Chinese, and Japanese, as it is one of the most nutritious of the vegetables. It is also used as a constituent of certain of their sauces and as a source of oil. It is grown in large acreage in this country for the improvement of the soil and as a stock food, but thus far has found little use in the human dietary owing to its peculiar flavor, though its products are being developed and used in other ways.
The seeds are small, plump, oblong, a little larger and about the same shape as the pea bean, yellowish, brownish, or dark colored. When cooked, they have a peculiar fatty flavor that is unpleasant to most persons. An attempt has been made to pack them in the same manner as white beans and also to mix them with white beans, but without success from a sales standpoint.


The term "beans" appearing on the label of canned beans, in the opinion of the bureau, conveys the impression that the beans are pea or medium beans. Cans containing soy beans, or beans of any variety other than pea or medium beans, should be labeled so as to show plainly the name of the variety.

Garbanzos

*Cicer arietinum*

The Garbanzo or chick pea is of Asiatic origin and also grown commonly about the Mediterranean. While it belongs to the Leguminosae, it is quite different from our bean. The seed is roundish and wrinkled, about three-eighths of an inch in diameter, and of a light color. It is grown in the southwest, and its consumption is largely in the South, Mexico, and the West Indies, though in recent years there has been an appreciable use in the eastern part of this country. It has a distinctive and peculiar flavor popular with Latin people. A few are packed in this country, the method followed being similar to that for the red kidney bean.

**APPENDIX**

**Cutters**

Patent No. 674,273, May 14, 1901, issued to E. J. Lewis, Middleport, New York, is for a device for cutting beans into uniform lengths. It consists of a drum on the circumference of which are projecting wings parallel to its axis. These projections are thin and divide the surface into grooves about an inch in width to hold the pods. Slits are made in the wings and spaced equal to the length of cut bean desired. A series of knives attached to a bar above the drum are adjusted to work in the slits so that a pod passing under is cut into uniform lengths.

This was the first special device intended to expedite the handling and to increase the capacity in packing beans.

Patent No. 925,614, June 22, 1909, issued to Z. P. Townsend, Sauquoit, New York, is for a bean cutter. The beans feed from a box upon a vibrating hopper that causes the pods to be arranged parallel and with one end forward, they slide downward and feed between a roll and a cutter made up of a series of blades properly spaced and mounted between two wheels attached to a shaft.

**Graders**

Patent No. 696,189, May 25, 1902, and 709,646, September 23, 1902, issued to W. F. Pillmore and D. Anderegg, Westeruville, New York, is for a grader. It consists of a long box divided into three sections. The
bottom and top of each section is provided with rods spaced to correspond to the diameter of the pod desired in a grade. The box is given a backward and forward movement and when the screen on the bottom becomes clogged, the box is turned over so that the one which was on top serves as a bottom. The beans are fed into the end. The device lacks capacity and is of interest chiefly as marking the first attempt to get a uniform product.

Patent No. 721,421, February 24, 1903, issued to J. W. Carnochan, Silver Creek, New York, is for a bean grader consisting of a series of inclined screens made of metal bars spaced to the width desired for the diameter of the beans. These screens are given a side to side vibrating motion and at the same time an independent rocking motion of the rods. Beans are delivered from a hopper and distributed so they will tend to move forward lengthwise and parallel with the bars, those of smaller size than the screen fall through, and those of larger size pass over the end. The graded beans are discharged into boxes or upon belts.

Patent No. 1,295,642, February 25, 1919, issued to W. E. Urschel, Valparaiso, Indiana, is for a grader in the form of a hollow cylinder with graduated openings in its walls and a mechanism within tending to cause the beans to fall into the openings.

Patent No. 1,316,165, September 16, 1919, issued to J. King, Mexico, New York, is for a grader. Instead of the screens being made of metal rods as in the earlier type, they are made of flat metal bars, spaced in essentially the same way and in this instance given a backward and forward vibrating movement. Above the bars is a light metal belt with spring fingers which push between the members of the metal screen and thus prevent clogging by the beans.

Snippers

Patents No. 1,062,663, May 27, 1913, No. 1,076,225, October 21, 1913, and No. 1,098,398, June 2, 1914, issued to W. B. Phinney, Chillicothe, Ohio, for a snipping device of rather complicated character. The beans are fed into pockets on a wheel or belt, the pocket being so small that the beans rest in one direction. The downward end of the bean projects beyond the pocket and is clipped off by a knife. The pockets are then turned so that the opposite end of the bean projects from the pocket and is clipped off in a manner similar to the first. The apparatus marks the first attempt at mechanical snipping.

Patent No. 1,086,056, February 3, 1914, issued to L. Janquart, Menominee, Michigan, is for a snipper the essential features of which consist of a continuous conveyor made up of a series of narrow guides without bottoms. The beans lie in the guides and at one stage are moved to one end to permit clipping the tip and then moved to the opposite end to repeat the operation. The lateral movement of the pods is effected by running over belts which are passing in a diagonal direction to the line of travel of the conveyor.

Patent No. 1,091,787, March 31, 1914, issued to R. C. Adams, Buffalo, New York, is for a snipper consisting of a series of narrow boxes attached at their middle to a conveyor chain. The top of each box is open and the beans are carried lengthwise in the box. At one stage the box tilts one end downward so that the beans fall in that direction and the lower ends
project and are cut off; at the next stage the box tilts in the opposite direction and the other end of the pod is clipped in the same manner as the first.

Patent No. 1,102,808, July 7, 1914, issued to F. A. Shoman, Milwaukee, Wisconsin, is for a snipper utilizing the principle of a series of parallel boxes attached to a chain conveyor, the box passing over the end pulley of the conveyor and under a guard, drags the beans across a belt moving at right angles to the line of box travel. This pulls the beans to one end of the box to have the end cut off and the belt movement is changed to the opposite direction to move the pods to the opposite end of the box to have the other end of the pod clipped.

Patent No. 1,113,307, October 13, 1914, issued to J. W. Carnochan and F. H. Damon, Rochester, New York, is for a bean snipper consisting of a large number of small hoppers arranged radially on a shaft. The beans fall into the hoppers and naturally the end strikes the bottom. In the rotation the lower end of the pod is clipped off and the beans are discharged from the hopper into another of the same kind on another shaft where the process of clipping is repeated.

Patent No. 1,116,930, November 10, 1914, issued to W. L. Schroder, Winneconne, Wisconsin, is for a snipper consisting of a conveyor to arrange the beans in single file and to deliver them into pockets on the periphery of a hollow drum. The beans fall in a vertical position in the pocket and one end projects through far enough so that a knife snips off the proper amount. As the drum rotates, the beans fall back in the pocket and the clipping is repeated on the opposite end.

Patent No. 1,136,588, April 20, 1915, issued to K. M. Davies, Williamson, New York, is for a snipper utilizing the principle of pairs of small hoppers to hold a single pod. The hoppers are mounted on the periphery of a horizontally moving wheel. The bean is received from the feeder in the first hopper and the lower end is clipped by a knife. The hopper is inverted and delivers the bean into another where the operation is repeated.

Patents No. 1,155,454, and No. 1,155,455, October 5, 1915, issued to F. Wegner, Fairport, New York, are for a snipper consisting of a series of small hoppers arranged transversely to, but connected on, an endless conveyor. The beans are fed lengthwise into the hopper. The bottom of the hopper is made movable so as to place the beans first at one end and then the other of the hopper where the ends are cut off.

Patent No. 1,189,323, July 4, 1916, issued to F. Wegner, Fairport, New York, is for a bean snipper using large screws for advancing and placing the pods for cutting, in place of the usual conveyor with boxes or hoppers.

Patent No. 1,190,393, July 11, 1916, issued to M. J. Langton, Oswego, New York, is for a snipper having a continuous conveyor with channeled units to hold single pods. It requires hand feeding. The beans are brought into position for clipping by means of belts set at an incline to the conveyor.

Patent No. 1,193,935, August 8, 1916, issued to A. M. Smith and C. C. Brown, Le Roy, New York, is for the usual continuous conveyor with channel units for holding the beans, but using revolving brushes to place the beans at either end for snipping.

Patent No. 1,239,227, June 19, 1917, issued to E. A. Salter, North Rose, New York, is for a snipper having a series of hopper boxes on a continuous conveyor, a brush moves the beans into position for trimming and a spring clamp holds them while the cutting is done.
Patent No. 1,246,110, November 13, 1917, and 1,256,023, February 12, 1918, to W. Killingsworth, Chillicothe, Ohio, is for a snipper of the usual type with troughs attached to an endless conveyor but the beans are drawn first to one end and then to the other by suction.

Patent No. 1,253,254, January 15, 1918, issued to J. King, Mexico, New York, is for a snipper having a number of small hoppers to receive the beans arranged in a parallel position. In the continuous movement of the hopper a mechanism causes vibration and tilting of one end downward so that all beans touch that end. A fixed knife cuts off the ends. The hopper is tilted in the opposite direction and the same sort of vibration given with the same result in placing the pods and then cutting them off.

Patent Nos. 1,256,491 and 1,256,492, February 2, 1918, and No. 1,336,991, April 13, 1920, issued to W. E. Urschel, Valparaiso, Indiana, are for a snipper employing a new principle, that of an inclined rotary drum with hazards on the inside which tend to cause the pods to fall with one end toward the wall. The drum has a number of slots stamped or cut into it through which the beans project. At one point in the travel, the projecting ends are cut off. The beans fall back and in time the other end is caught and clipped.

Patent No. 1,257,164, February 19, 1918, issued to F. W. Wegner, Fairport, New York, is for a snipper with the usual hopper carrier with the bottom open. A large revolving disk serves to move the bean into position for clipping the ends. The cutting is done in the usual way.

Patent Nos. 1,351,088, and 1,351,143, August 31, 1920, issued to E. J. Vaudreuil, Eau Claire, Wisconsin, is for an apparatus utilizing the same principle as in No. 1,256,491, but has a coarse wire screen on the inside to direct the end of the pod into the openings in the drum.

Patent No. 1,358,002, November 9, 1920, issued to D. Lash, Winslows Mills, Maine, is for a snipping device, utilizing the principle of a rotary drum and guides for directing the beans into position so that each end will be cut off.

Patent No. 1,359,559, November 23, 1920, issued to A. P. Wolfe, Philadelphia, Pennsylvania, is for a snipper employing either a rotary disk or a conveyor with suitable grooves or ridges for holding the beans in proper position and brushes for working them into place for having the ends cut off in successive operations.

Patent No. 1,365,328, January 11, 1921, issued to C. Krotzer, St. Bonifacius, Minnesota, is for a bean snipper of rather distinctive type. Beans are caught on an elevator which has such small cross pieces that only one bean is lifted at a time, carried and deposited on the periphery of a drum also provided with carrier pockets to hold only one bean. The beans are advanced under a series of parallel mounted knives on a shaft and are adjusted so that only the knives at the end of a bean will do the cutting. In this machine, both ends of the bean are snipped at the same time.

Other Patents

Patent No. 1,235,680, August 7, 1917, issued to A. Greco, San Jose, California, is for a form to hold beans while being cut, and also for depositing them in the can. The form is made the exact length desired for a given size can and is slightly less in diameter than the can. The blanched beans are filled into the form which when full is closed, the projecting ends of
the pods cut off, and then the end of the form inserted into the can, thereby
delivering the beans packed in what is known in the trade as "asparagus
style."

Patent No. 1,315,056, September 2, 1919, issued to O. J. Tubbs, Wins-
low, Maine, is for a cutting box to cut beans to desired lengths for canning
whole.

Patent No. 1,344,069, June 22, 1920, issued to E. J. Vaudreuil, Eau
Claire, Wisconsin, is for a process of preparing string beans. The larger
sizes, Nos. 3, 4, and 5, are run through a bean cutter and the snipped ends
separated by a grader. The snipped ends are smaller and are easily re-
moved. The advantage claimed is in saving labor.

Patent No. 1,338,035, April 27, 1920, issued to J. A. Olsen, Copen-
hagen, Denmark, is for a device for cutting the string at short intervals,
as one-fourth of an inch. It has little practical use in canning since the
development of stringless varieties.

**BEETS**

_Beta vulgaris, L._

The table and sugar beet have a common origin though they differ
trough modification of certain characters, as, for example, the color in
one and the high sugar content in the other. The progenitor of the species
was _Beta maritima, L._, native of the shores of the Atlantic and the Mediter-
ranean, the region of the Caspian Sea, Persia, and India. The antiquity of
the plant under cultivation has been estimated by De Candolle to be from
four to six centuries before the Christian Era. The earliest part used was
the leaves due undoubtedly to the fact that the roots were only slightly
developed and fibrous. Theophrastus, Dioscorides, and Galen, writers of
the early Christian Era, give the medicinal virtues of the beet but make no
reference to its culinary uses. Columella, Pliny, and Palladius, naturalists
of about the same period, do not refer to its culture which is at least strongly
indicative that it had no important place in their time. From that time
forward through the Middle Ages the beet became the most important
pot-herb, but it was not until it became cultivated in more central and
northern Europe, that is, under cooler climatic conditions, that the root
portion became the important part. The turnip-like rooted beet, such as
we have at present, is in reality a comparatively modern development that
came from Germany about 1500. It was taken into Italy and from there
distributed over the other countries of Europe. Matthole, an eminent Ital-
ian physician and botanist, in 1558 gives the earliest explicit information
upon the betterave (table beet) and is quoted as follows by Gibault: "In
Germany there are plants with red leaves and roots which are as large as
turnips and are so red that one might consider their juice to be blood.

"In winter, the Germans eat their roots, cooked between two embers;
and, despoiled of their skin by degrees, they eat them in salad with a little
pepper, as one does carrots, and find them better tasting than carrots. They
are used likewise with roast meat, being cooked a little, cut across in pieces
and put in stews and mingled with some cut wild radish.”
The large rooted type of beet was rare as late as 1549, being found only in the gardens of the nobles. Olivier de Serres, the French authority upon agriculture, author of *Theatre d'Agriculture* (1600), says: "A species of pasternade (ancient name for carrot) and parsnip is the betterave; which has come to us from Italy not a long time ago. It has a very red root, rather large, of which the leaves are all that are good to eat; the juice that the root gives up in cooking appears to be a sugar syrup, and is very fine to see for its vermilion color." Fifty years later the plant had become common and was introduced into England in 1656.

Seedsmen and gardeners paid considerable attention to the beet and developed many varieties differing in the shape of the root, as the slender conical, the long more or less cylindrical, globular and flattened, globular, etc. Up to the nineteenth century, the color was not so important, the preference for general consumption being for the yellowish which is sweeter and has a more characteristic flavor. At present the demand is for red in the beets for table purposes.

**The Plant**

The plant is a herbaceous biennial with a single enlarged root. A clump of rather coarse leaves with fairly long fleshy stems arise from it just above the ground, are from 10 to 18 inches in height, and have a weedy look. The root may have the enlarged portion above the ground or be partially or wholly covered. The flowers develop the second year and are inconspicuous.

The beets need a dark friable loam, moderately moist, to produce roots of the best canning quality. Experience has shown that a dark soil contributes to a darker and better color than a light or sandy soil and that looseness is favorable to a globular shape. The roots are frequently misshapen when the crop is grown on a firm soil, thus increasing the labor of preparation.

In the northern and eastern sections of the country, it has been customary to sow the seed late in the spring so that the roots do not attain undesirable size nor mature before cool weather and for the further reason that it was a current belief that beets maturing in cool weather are of a superior quality in flavor and texture. Lately the sowing has been done early to have the crop at its proper stage of development in midsummer or a little later, following the example of the northwest section where the crop is harvested between the last week in July and the first week in September. Sufficiently heavy seeding is done to favor crowding of the tops and thus to keep the growth in check. About eight pounds of seed per acre suffice for this purpose. The plants are grown in rows about 18 inches apart to permit of horse cultivation to keep down the weeds. The labor and difference in cost of producing small and large beets is so great that a tentative schedule for payment has been proposed at $25 per ton for those less than 1 3/4 inches in diameter, $15 per ton for those above 1 3/4 inches to 3 inches, and $8 per ton for those more than 3 inches in diameter.

**Volume Canned**

While the packing of beets is small by comparison with several other vegetables, it amounts to about 1,500,000 cases annually, but reached a total of 2,923,000 cases in 1930. Nearly 150 canners in 15 states pack some
beets but there is no large packer. The principal packing is done in New Jersey, New York, Wisconsin, and Oregon. Hotels and cafeterias are becoming the principal users as the canned product insures uniformity and quality at all seasons, whereas the fresh market does neither.

**Harvesting**

Formerly the harvesting was a hand operation known as "pulling and topping," but that has become greatly modified at present. A plow or cultivator is run alongside of the row to loosen the beets so they may be picked up and tossed upon a wagon. At the factory the tops are removed by a special machine called a topper. One or two pairs of eccentric mounted rolls, set on an incline, are made to turn toward each other, and these rolls are so spaced that the leaves are drawn through and the root remains above. A machine having two pairs of rolls will top from four to five tons per hour, and with the added advantage that the beet bleeds less than when the topping is done with a knife.

It is found advantageous to hold the topped beets in boxes or crates for two or three days that a slight wilting may occur, enough to permit the skins being removed more readily than when they are crisp and tender. Some persons believe that the wilting fixes the color to some extent, but upon this point there is no experimental evidence. The fact that the roots do not have to be canned immediately upon being harvested, as necessary with so many vegetables, makes the work easy, and avoids rush operations, and, by timing the crop to come late in the fall, the labor and factory costs are generally less than in summer.

**Grading**

Beets are graded in various types of graders; as, the simple rotary grader with wooden slats spaced to permit the roots of different diameter to pass through at different points, vibrating slat screen, vibrating fruit grader having holes cut in the metal shakers, and the Trescott type of link grader. The grading may be done either before or after topping, depending upon the kind of grader used, but preferably after topping as a higher degree of accuracy can be obtained and an increased capacity. The rotary drum grader has an advantage in that the beets rub against each other and the machine and thus remove a large part of the adherent dirt. The fruit grader type gives more nearly accurate results.

The sizes have not been standardized, but a proposed standard and the one which has met with most approval is as follows, also indicating approximately the number of beets for the cans of the sizes designated:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Number in</th>
<th>Number in</th>
<th>Number in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under</td>
<td>No. 2 Can</td>
<td>No. 3 Can</td>
<td>No. 10 Can</td>
</tr>
<tr>
<td>1 inch</td>
<td>50</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>1 3/4 inch</td>
<td>35</td>
<td>60</td>
<td>200</td>
</tr>
<tr>
<td>1 1/2 inch</td>
<td>25</td>
<td>40</td>
<td>130</td>
</tr>
<tr>
<td>1 1/8 inch</td>
<td>15</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>1 3/8 inch</td>
<td>10</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>1 1/4 inch</td>
<td>7</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>2 inch</td>
<td>10</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

The objection urged against this proposal is that it provides for too many sizes, whereas many packers consider four to be ample, and that multiplicity adds to the costs.
Small beets, or those less than $1\frac{1}{2}$ inches in diameter, are the ones most suitable for canning as whole beets. Those above that size and less than 2$\frac{3}{4}$ inches make the best slices, while those under 3$\frac{1}{2}$ inches may be diced if tender. Beets of large size are almost certain to have coarse or even woody rings and be irregularly colored, thus rendering them unsuitable for a high grade product.

**Washing**

As the beet must be skinned, some packers give little attention to the washing under the mistaken notion that any foreign matter is removed with the skin. If the soil be tightly adherent, the beets need to be dumped into a tank to soak for several minutes, and then well sprayed to prevent any contamination during subsequent operations. This is particularly important if any type of abrasion peeler be used.

**Peeling**

Peeling is effected in two stages: first by pre-cooking, preferably in a retort, to loosen the skin and incidentally to set the color, and second, removing the skin by scraping or other suitable means. The retort crates are first lined with strips of wood, or heavily tinned wire baskets are set inside to prevent the beets coming in contact with the iron. Small beets are filled in layers only about 4 inches in depth and large ones up to 8 or 10 inches. The spaces between the small beets are so much less that the distribution of heat is uneven if the layer be of too great depth. The time required for heating in the retort varies from as low as 4 to 10 minutes at $220^\circ$ F. for small beets up to 20 minutes for the large ones. Some packers use boiling water for the pre-cooking, in which event the time is increased. It is desirable that the interior of the beet be brought up to at least $150^\circ$, which generally takes somewhat longer than is necessary for loosening the skin. A standard vertical retort has a capacity of about 25 bushels per hour, and five retorts are required for one line operating at 50 cans per minute or 1,000 cases per day.

The beets are sprayed with cold water to arrest the action of the heat. They may be peeled either by the usual centrifugal machine used for paring potatoes and be hand trimmed, or all the work can be done by hand. The former is the more rapid and less expensive method but does not leave the beet as smooth as all hand work. An ordinary centrifugal machine has a capacity of about 600 pounds per hour and experience indicates that to increase factory capacity, it is better to add to the number of machines rather than to their size. Eight machines are needed in a one line plant. For use on the smaller beets, it has also been found better to use abrasive which has been partially worn.

The peeled beets are kept submerged in water until ready to be filled into the cans, a precaution that is desirable in order to limit any bleaching of color due to the action of the air.

It requires on an average, forty women to peel and fill cans for one line when all the work is done by hand.

**Slicing**

Various types of fruit and vegetable slicers are used for this operation, but preference is given to that having a horizontal disk with knives and
vertical chutes for feeding the beets. If the slices are to be cut across the rings, the cut giving the best appearance, then the feeding must be done by hand to insure that the beets enter in the proper position. This limits the capacity of one operator to about fifty beets per minute, but two can work at one machine. The capacity of one machine is from 1,000 to 1,200 pounds per hour or about the proportion of large beets normal to a one line plant. The slices may be cut from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in thickness, the most satisfactory being $\frac{1}{4}$ of an inch. When handling beets, enamel finished tables and pans are best, with wood or fiber as second choice.

**Filling**

The cans are filled to about $\frac{3}{8}$ inch of the top so as to leave room to cover the beets with brine, otherwise any portion of them that projects above the brine into the headspace becomes discolored to a greater or lesser extent. Sliced and diced beets need to be filled by weight to prevent irregular filling and overweight. This applies especially to sliced beets, for these have a way of stacking and adhering that defy all the laws of chance as developed by mathematicians. The spaces between whole beets permit ready circulation of hot brine and thus sterilization is easily effected, whereas in sliced beets the circulation may be poor, if there be over-filling. Enamel-lined cans only are used.

**Cooking**

Ordinarily beets are easily sterilized, and yet there are cases where spoilage occurs when a fairly severe cook is given. Formerly, when plain cans were used, beets were cooked at boiling only, 1 hour for No. 3 can, and 1½ hours for the No. 10. High temperatures affect the color especially in plain tin, but with the better lacquer-lined cans little change takes place below 230° F. if the time be not too prolonged; and this may be raised to even 245° for a few minutes if the cooking be followed by immediate cooling to atmospheric temperature.

The cook now recommended for beets is 240° F. for 25 minutes for No. 3 cans and all sizes below, and 40 minutes for the No. 10 size. An alternative is 230° for 50 minutes for No. 3 cans and below, and 65 minutes for No. 10. Glass is being used in increasing quantities for the packing of beets, especially the 20 ounce jar, the time for cooking at 240° being 30 minutes and at 230° for 55 minutes.

The State of California requires a cook at 240° for 25 minutes for No. 3 cans and below, and 40 minutes for No. 10 cans, or 248° for 15 minutes in the smaller cans and 20 minutes in the No. 10 cans. Sliced beets are required to have 5 minutes more in the larger cans at 240° or 3 minutes additional at 248°.

Beets are packed only upon a small scale abroad and until recently the French and Germans used 220° for 25 minutes for liter cans (No. 3) and smaller. The Germans have changed to 240° for 15 minutes.

**Label Weights**

(See Gr. 1.04) : 8Z Short, 7½ ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 8 ozs.

Vacuum pack: No. 2 Squat, 10 ozs.; No. 3 Squat, 1 lb. 2 ozs.
UNITED STATES STANDARDS FOR GRADES OF CANNED BEETS
(Effective May 21, 1935)

Definition
Canned beets are the canned vegetables prepared from whole, succulent, tender beets (Beta Vulgaris) of any red garden variety, by topping, thoroughly washing, steaming, properly peeling and trimming, and by the addition, before sterilization, of the necessary quantity of potable water, with or without the addition of salt, packed in hermetically sealed containers and sterilized by heat.

Styles of Canned Beets
Whole beets are beets which retain their original conformation after trimming and peeling.
Sliced beets are whole beets so sliced that the slices are of practically uniform thickness not exceeding \( \frac{3}{8} \) inch from which the “slabs” or first cuts have been removed.
Quartered beets are whole beets which have been so cut that the beets are divided into four approximately equal units. Beets which have been cut in half, the units of which approximate in size the quartered units in the can are also permitted in this style.
Diced beets are whole beets which have been cut into cubes approximately \( \frac{3}{8} \) inch square.
Cut beets are beets which may or may not have been whole, and which are cut into unsymmetrical pieces not conforming to any of the above named styles.

Grades of Canned Beets
U. S. Grade A (Fancy) canned beets possess a typical deep red color, are practically uniform in size, being 1\( \frac{1}{4} \) inches, or less, in diameter if packed whole, and not more than 2\( \frac{1}{2} \) inches in diameter if sliced or quartered; if sliced, the slices are not to exceed \( \frac{1}{8} \) inch in thickness; are practically free from blemishes, partially peeled or poorly trimmed beets, and other defects; are very tender and succulent; possess a normal beet flavor; and score not less than 85 points when scored according to the scoring system outlined herein.
U. S. Grade C (Standard) canned beets possess a good red color; are fairly uniform in size, being not more than 2 inches in diameter if packed whole, nor more than 3\( \frac{1}{2} \) inches in diameter if sliced or quartered; if sliced, the slices are not to exceed \( \frac{3}{8} \) inch in thickness; are reasonably free from blemishes, partially peeled and poorly trimmed beets, and other defects; are fairly tender; possess a normal beet flavor; and score not less than 70 points when scored according to the scoring system outlined herein.
Off-Grade (Substandard) canned beets are beets that fail to meet the requirements of the foregoing grades, or that fall below any standard for canned beets promulgated under the terms of Section 8, Paragraph 5 of the Federal Food and Drugs Act of June 30, 1906, as amended.

Meaning of Normal Flavor.
"Normal flavor" means that the product is free from objectionable or off flavors of all kinds. Canned beets in which objectionable or off flavors are detected, if not illegal, but otherwise meet the requirements of Grade A or Grade C, will be graded Off-Grade (Substandard).

Prerequisites to Grading
Fill of Container. Cans of beets shall be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container, and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.
A certificate of grade covering canned beets that do not meet the above requirements shall bear the legend,
"Below U. S. Standard"
"Slack Fill"
A certificate of grade covering canned beets that do not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,
"Below U. S. Standard—Slack Fill"
"Contains Excess Added Liquid"
Drained Net Weight and Head Space Requirements. Drained net weights of beets are determined by emptying the contents of the container upon a circular sieve of proper diameter containing 8 meshes to the inch (0.097 inch perforations), and allowing to drain for 2 minutes. The sieve diameters used are: 8 inches for No. 3 size cans or smaller, and 12 inches for cans larger than No. 3.

The minimum drained net weight and the maximum head space allowable in the sizes commonly used in packing canned beets are shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum Capacity in Water at 68° F. (in ozs.)</th>
<th>Minimum Drained Net Weight (in ounces)</th>
<th>Maximum Head Space Allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>13 1/2</td>
<td>14 1/4</td>
</tr>
<tr>
<td>No. 2 1/2</td>
<td>29.79</td>
<td>15 1/2</td>
<td>16</td>
</tr>
<tr>
<td>No. 3</td>
<td>35.08</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>60</td>
<td>67</td>
</tr>
</tbody>
</table>

Count—If packed whole, the number of beets shall be within the range of count claimed for beets, and in no case less in a given can than the number designated in the following table:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Grade A</th>
<th>Grade C</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 2</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>No. 2 1/2</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>No. 3</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>No. 10</td>
<td>75</td>
<td>35</td>
</tr>
</tbody>
</table>

Ascertaining the Grade

The grade of canned beets may be ascertained by considering, in addition to the foregoing requirements, the following factors: Color, uniformity of size, absence of defects, tenderness and texture, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color</td>
</tr>
<tr>
<td>II. Uniformity of size</td>
</tr>
<tr>
<td>III. Absence of defects</td>
</tr>
<tr>
<td>IV. Tenderness and texture</td>
</tr>
<tr>
<td>V. Flavor</td>
</tr>
</tbody>
</table>

Total 100

Ascertaining the Rating for Each Factor. The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 8 to 10 means 8, 9, and 10.

I. Color.

Note—The colors mentioned are according to illustrations in Ridgway's "Color Standards and Nomenclature."

(A) To receive a rating within the highest group, 17 to 20 points, the beets must possess the typical color of dark, deep red—that is, Carmine to Oxblood—varieties of garden beets. Beets that fail to meet this requirement shall not be graded above U. S. Grade C (Standard) regardless of the total score for the product.

(C) If the color of the beets ranges from light to medium Carmine—that is Nopal red to Carmine—or shows a slight presence of light rings, a credit within the range of 0 to 13 points may be allowed.

(D) Beets that possess a poor color as, for example, a brownish—Morocco red—color, a credit within the range of 0 to 13 points may be allowed.

II. Uniformity of Size.

(A) To receive a rating within the highest group, 8 to 10 points, the product must be symmetrical and practically uniform in size—that is, whole beets whose diameters shall not vary in size more than one-fourth inch from the largest to the smallest beet. In the case of sliced beets, the variation
in diameter from the largest to the smallest slice in any given can shall not exceed one-half inch. If quartered, the quarters shall be approximately equal and uniform. Diced beets shall be cut into full practically uniform cubes 3/8 inch square. Beets that fail to meet this requirement may not be graded U. S. Grade A (Fancy), regardless of the total score for the product.

(C) If the beets are but fairly uniform in size and symmetry, failing to meet the above size limitations and requirements, a credit of 5 to 7 points may be allowed.

(D) If the beets are markedly irregular in size and symmetry, a credit within the range of 0 to 4 points may be allowed.

III. Absence of Defects—Under the factor of absence of defects, consideration is given to defects, such as blotch, stam, or internal discoloration, scab, poor trimming and/or peeling, insect or mechanical injury, or other evidence of poor workmanship. If diced, sliced, or quartered, the presence of end cuts or "slabs" and of small chips ordinarily removed in the process of preparation shall be considered as defects.

(A) Beets that are practically free from the defects mentioned may be given a credit of 13 to 15 points.

(C) If defects are noticeable but not so excessive as to detract seriously from the appearance of the product, the beets may be given a credit of 10 to 12 points.

(D) If defects are prominently present, a credit within the range of 0 to 9 points may be allowed. Beets that fall in this classification shall not be graded above Off-Grade (Substandard), regardless of the total score for the product.

IV. Tenderness and Texture—Under the factor of tenderness and texture, consideration is given to the character of the product—that is, its tendency to be tender and succulent, or contrariwise, to be coarse, stringy, or fibrous.

(A) Beets that are very tender and succulent, with fine and even texture free from stringiness, may be given a credit of 30 to 35 points.

(C) Beets that are fairly tender, being somewhat coarse and stringy, and possess somewhat tough fibre, may be given a credit of 27 points.

(D) Beets that are very firm or tough, or with decidedly coarse texture, stringiness, or pronounced fibre, or contrariwise, are noticeably soft, may be given a credit within the range of 0 to 26 points. Beets that fall in this classification shall not be graded above Off-Grade (Substandard), regardless of the total score for the product.

V. Flavor—The quality of flavor of canned beets is classified from the standpoint of palatability, and the distinctness of the flavor characteristic to young garden beets.

(A) Beets that are very palatable and possess the flavor typical of young beets may be given a credit of 17 to 20 points.

(C) If the flavor is indistinct, weak or somewhat bitter, a credit of 14 to 16 points may be allowed. Beets that fall in this classification shall not be graded above U. S. Grade C (Standard), regardless of the total score for the product.

(D) If the flavor of the beets and/or liquor is abnormal, possessing a metallic, decidedly bitter, excessive salt or poor taste, a credit within the range of 0 to 13 points may be allowed. Beets that fall in this classification shall not be graded above Off-Grade (Substandard), regardless of the total score for the product.

Troubles

Discoloration in canned beets may arise from various causes, the most common being bleaching, as shown most distinctly in the rings which become light due to soaking in water too long; irregular discoloration varying from a grayish to brownish, due to exposure between the time of peeling and placing in the can, and most noticeable in beets which have been insufficiently heated in the preliminary step; a pale or purplish effect due to the use of plain cans, the remedy for which is obvious; discoloration...
due to beets projecting above the brine in the can, which may vary from near normal through every degree to a dark brown, the remedy being the use of brine to cover and a thorough exhaust. The beets or pieces affected become mixed with the others during transportation and handling so that the real cause may not be suspected. These troubles are most apparent in beets that have stood in a warehouse undisturbed and the samples taken when shipment is being made.

A dark discoloration due to bacteria also occurs, first reported by Duck-wall in 1908. He described the causative organism as a streptococcus, difficult to grow by the usual cultural methods. It causes the beets to become alkaline and develop a small volume of gas though not enough to release the vacuum and, therefore, the can appears to be sound until it is opened. The discoloration produced corresponds with the degree of alkalinity. He reports the organism not highly heat resistant requiring a temperature of 218°F. for 40 minutes only for sterilization.

A further discoloration; that is, a light grayish sediment on the surface of beets, rarely noted in tin, but seen in glass, is described by A. E. Stevenson*, as being due to the use of hard water. The calcium in the water combines with the oxalates in the beet to form calcium oxalate crystals which produce the light gray appearance. The calcium may also be introduced with the salt.

The packers in glass also have difficulty due to bleaching when jars are held too long in strong light.

**Food Value**

The beet is rather low in food value as indicated by chemical analysis but is appreciated as a change in the diet. It is frequently pickled and in that form makes an agreeable relish.

The composition of the beet as given by Wiley is as follows:

<table>
<thead>
<tr>
<th>Per cent</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>88.47</td>
</tr>
<tr>
<td>Ash</td>
<td>1.04</td>
</tr>
<tr>
<td>Protein</td>
<td>1.53</td>
</tr>
<tr>
<td>Fiber</td>
<td>.88</td>
</tr>
<tr>
<td>Sugar and starch</td>
<td>7.94</td>
</tr>
<tr>
<td>Fat</td>
<td>.14</td>
</tr>
</tbody>
</table>

The coloring matter of the beet is soluble so can be washed out of thin slices. It is fairly sensitive to acids and alkalis, being red in the acid and changing to brown in the alkaline, the intensity of the color bearing a relation to the alkalinity.

**Beet Tops**

Young beet tops are sometimes used for greens and a few are canned. The methods followed are essentially the same as for spinach.

As sauerkraut is cabbage which has undergone fermentation under conditions provided for that purpose and is the more important product from the canner’s standpoint, the fresh and manufactured products will be considered together.

Botanical Characters

Cabbage, *Brassica oleracea*, belongs to the large family of plants known as the Cruciferae or mustards. It is a slow growing, herbaceous biennial, the first season being limited to vegetative growth, the second to flowering and the production of seed. It presents an exceedingly diverse appearance due to modifications which have taken place under the varying cultural conditions to which it has been subjected, the degree of variation probably being greater than noted in any other plant. In the wild state it grows to a height of from ten to forty inches, branched, the leaves few, more or less lobed and undulated at the edge, not very fleshy, the petioles varying in length, but without the formation of heads. The flowers are borne on stems which arise from the axils of the leaves the second year, are small, four-parted, white or yellowish, and followed by a rather long seed-pod.

The variations are in the direction of more sturdy forms with distinctly fleshy glaucous leaves; plants with more or less wrinkled leaves without heads, as kale, borecole, and collards; headed forms where the stem and petioles atrophy permitting the leaves to form a more or less compact head as the small loose-headed summer varieties used as a fresh vegetable; wrinkled or net-leaved head varieties as the Savoy; and the large compact headed varieties of which the Flat Dutch is the type. A further modification in a different direction is seen in the Brussels sprouts, or plants having a long stiff stem with many small heads set close around the sides instead of one at the top; plants in which the flowering parts become fleshy and coalesce as in cauliflower and in a much less degree in broccoli; and finally a type in which the stem becomes hypertrophic, for it is claimed by some botanists that the ruta baga turnip has the same ancestry. The usual head type of white cabbage has a short stem and many leaves closely compacted into a globular shape, is from 14 to 24 inches in height and about the same across where the lower leaves are expanded. The color varies from green to a grayish green, and from almost no bloom to a heavy bloom on the leaves. There are also varieties varying from pinkish to red and some distinctly purple.

Domestication

Cabbage is one of the oldest of the cultivated plants as its use antedates written records. It was well known to the Egyptians, the Greeks, and the Romans, and the earliest descriptions indicate that they had the white or headed variety which must have been domesticated for a long time to have undergone the modifications then noted when it is compared with the wild type. It is native to many parts of Europe especially along the coast and in the British Isles; found growing among rock, on chalk cliffs, in the open, and although classed as a fairly hardy plant, is easily injured by frost when young. The white or head type can be grown almost anywhere in a temperate climate, but responds best in a comparatively cool, moist region, as in northern Germany, Holland, Belgium, Denmark, France, and the British
Isles in Europe, about the Great Lakes, and the north Atlantic and Pacific
seaboards in this country. It has also been found to do well in the high
altitudes of Colorado, Utah, and Idaho, and near the Gulf coast during
the cooler portions of the year. In the process of domestication it has
acquired new habits and now thrives best on a rich soil, which is moist
but not wet.

The use of cabbage as a cultivated vegetable in northern Europe is
attributed to the Romans, the headed variety being introduced by them
after the conquest of the country, and later becoming an important article
in the diet. The assertion so often made that cabbage, and particularly in
the form of kraut, is of Germanic origin, does not seem to be well sus¬
tained, for those people were barbarians with nomadic habits when they
came in contact with the Romans about the beginning of the Christian Era,
and instead of bringing a cultivated plant for food, they must have learned
of its use. Even Attila, four hundred years later, had not learned the use
of bread. In fact, the only prepared food which seems to have been ob¬
tained from that source is butter. The cultivated form of cabbage in Eng¬
land was obtained from the Romans, and it is said that it was scarcely
known in Scotland until the time of Cromwell. Brussels sprouts have
been grown in Belgium for at least four hundred years according to some
writers and by others the plant is considered of recent origin. The singular
thing is that if it be so old, it was not described by the early botanists nor
was the term used until 1818. Cauliflower seems to have come from Italy
about 1600, and the broccoli from the same source a century later, but there
is nothing to show how much earlier these varieties may have originated
or been in use.

Cabbage was introduced into this country by the earliest settlers, prob¬
ably the Dutch, and gained an immediate and permanent place about New
York City and on Long Island.

The importance of the vegetable both abroad and here is seen in the
fact that more than 500 varieties have been listed by seedsmen. It is grown
in kitchen and market gardens over the entire country and in large tracts
in the South to supply the winter and spring markets, and in the North,
especially in New York, Pennsylvania, Ohio, Indiana, Illinois, and Wis¬
consin for kraut.

As might be expected, this plant has become so thoroughly domesticated
that it responds promptly to cultivation and in proportion to the care be¬
stowed on it. It will not make returns on poor land with little cultivation,
but may yield from 10 to 20 tons of heads per acre on rich soil under proper
tillage in the sections suitable for its growth. It does not differ from other
garden vegetables or require special treatment, and thus is easily grown by
any good gardener or farmer. It is subject to both plant disease and in¬
sert attacks, and these have been studied by the experiment stations in the
states where its production is important. Strains have been developed with
considerably increased resistance to certain diseases, especially root rot,
and other measures found to reduce the hazards of production.

Domestic Culture

Domestic cabbage culture has been differentiated along two lines, one
in the development of small quick-maturing heads to be used fresh during
the growing season and for shipment from southern fields to the northern
markets during the winter; the other in the production of the slow-maturing varieties for the fall and for winter storage, and the manufacture of sauerkraut. The early garden varieties are not well suited for this conserve, the waste is too large and the quality poor or only fair.

The seeds are sown in boxes or beds where they can be protected and when the young plants have a couple of leaves, are reset two inches or more apart and kept until ready to be planted in the fields, at which time they should be stocky and about four or five inches in height. If intended for kraut, they are planted from 18 to 24 inches apart in rows three feet apart and cultivated to keep the soil friable and prevent the growth of weeds. Very early plantings begin to mature the latter part of August or first of September, but better stock begins to come on towards the end of the month or early in October. The early stock is soft and the flavor sharp or rather acrid instead of mellow. The varieties most used for kraut are the Hollander, Wisconsin Hollander, Brunswick, All Seasons, Copenhagen, All Head Early, Flat Dutch, and Glory. The yield per acre varies considerably, the average for Wisconsin, Illinois, and Indiana is about 10 tons, with a maximum of 25 tons upon highly cultivated land and with favorable conditions.

Utility

Nearly the whole of the plant is edible and has been so used, but of late the custom is to use only the inner leaves or the portion blanched by the outer green leaves that is tender and sweet, with a mild flavor. The outer leaves are rather coarse and rough, somewhat astringent and with a strong flavor, but accredited with a higher food value than the inner leaves.

This vegetable has always had a peculiar place in the dietary, as an adjunct to make other foods more agreeable and digestible rather than for exceptional nutritional value of its own. Cato, in his manuscript, *De re rustica*, written about 200 B.C., lauds it as the most important vegetable the Romans had under cultivation, and this probably expressed the popular estimate at the time, as it was promptly introduced wherever they made conquests. In addition to its value as a food, it was believed to have uncommon medicinal properties for use in many illnesses, both when taken suitably prepared and as an external application for localized ailments. Among other things Cato states: "Cabbage favors digestion and dissipates drunkenness. If at a repast you wish to drink copiously and eat with appetite, eat previously raw cabbage preserved in vinegar, and as much as you like. Eat it again after the repast. It cures melancholy; it expels everything; it heals everything!" In fact, during a period beginning about 200 B.C. and continuing until about 450 A.D., it was the principal plant used in the Roman empire for the treatment of disease, particularly in the rural districts. It has been known for centuries as one of the best antiscorbutics and used as such by sailors when on cruises, and by the inhabitants of northern Europe during the long winters, the latter also esteeming it as a valuable vegetable. The peculiar antiscorbutic property is also present to a marked degree in the fermented product, sauerkraut, which doubtless accounts in some measure for the popularity of the dish among certain peoples. Captain Cook, the English navigator of the eighteenth century, was signalized honored for the manner in which he protected the health of his crew on his long voyage of exploration, and he ascribed their good con-
dition to the liberal use of that conserve. Recent investigations upon dietetics show this vegetable to be unusually rich in vitamins, especially the antiscorbutic vitamin, and thus accounts for its value, even though it be 90 per cent water. It would be a mistake to get the impression from the foregoing that cabbage is strictly a utilitarian vegetable suitable only to laborers and those of robust habits, for history also records that it has shared with more dainty dishes at wedding feasts of princes and princesses. The “up-to-the-minute” advertising expert can find ample material for making strong claims without drawing upon his imagination.

The United States Department of Agriculture has given out some figures upon domestic production of cabbage for the market and for the manufacture of sauerkraut which are recognized as being only approximate, as many small growers and small manufacturers fail to make returns. The total cabbage used by the larger kraut makers in 1927 was 163,000 tons, upon which basis it is conservatively estimated that the total for that purpose exceeded 200,000 tons. If one-eighth of the crop were used for kraut, which is believed to be near the actual proportion, the total was in the neighborhood of 1,600,000 tons. It is, therefore, clear that cabbage and kraut are important in domestic commerce. The principal kraut producing sections are in New York, Wisconsin, Ohio, Illinois, Indiana, Michigan, and Minnesota. The largest single firm is in New York State, and is said to pack 55,000 barrels annually.

Sauerkraut

The term sauerkraut is originally German, Anglicized; also abbreviated to kraut; French, choucroute. The earliest references which we have been able to find for a preparation of cabbage in which these terms are used are quoted by Charles Gerard in L'Ancienne Alsace a Table, 1877. One of his citations is that at a royal wedding feast celebrated at Ribeauville, November 6, 1543, Choucroute ornee de foie (Sauerkraut garnished with liver) was a part of the second course. Surely a good introduction into society. Another of his citations is to the effect: “I observe that the Kreuterbuch of Jerome Bock, republished at Strasbourg in 1577, by Dr. Melchior Sebizius, says sourcrout is a thing included for a long time in the domains of common food.”

Sauerkraut is defined in the Oxford Dictionary as follows: “Sauerkraut, sourcrout. A popular article of diet in Germany, consisting of cabbage which has undergone an acid fermentation. 1617. Moryson. Itin. Ill, III, iii, 83. They use to serve in sower crawt or cabbage upon a voide circle of carved iron. 1633. Hart. Diet of Diseased. They pickle it (cabbage) up in all high Germany, with salt and barberries, and so keepe all the yeare, being commonly the first dish you have served in at table, which they call their sawerkraut.”

Webster: “Sauerkraut. Cabbage cut fine and allowed to ferment in a brine made of its own juice and salt.”

Standard: “Sauerkraut. A German preparation of cabbage, made by cutting it fine, salting, ramming down tightly in a cask, and allowing it to ferment under pressure.”

Century: “Sauerkraut. A favorite German dish consisting of cabbage cut fine, pressed into a cask, with alternate layers of salt, and suffered to ferment until it becomes sour.”
International Encyclopedia: “A preparation of the common white cabbage, well known and in extensive use in Germany and the north of Europe, where it supplies during the winter the place of fresh vegetables. The cabbages are gathered when they have formed firm white hearts, and then carefully trimmed, are sliced into thin shreds; are placed in a succession of thin layers in a large tank, each layer being sprinkled with fine salt, to which some add juniper berries, cumin seed, caraway seed, and other condiments. The top is then covered and heavy weights placed thereon so as to press the cabbage down firmly, but gently; after a time fermentation begins and when a sour smell arises from the tank, it should be kept cool. It is generally eaten boiled, in the same way as fresh cabbage.”

The definition as formulated in a regulation under the Food and Drugs Act is as follows: “Sauerkraut is the clean, sound product, of characteristic flavor, obtained by full fermentation, chiefly lactic, of properly prepared and shredded cabbage in the presence of not less than two per cent (2%) nor more than three per cent (3%) of salt. It contains, upon completion of the fermentation, not less than one and one-half per cent (1.5%) of acid, expressed as lactic acid. Sauerkraut which has been rebrined in the process of canning or repacking contains not less than one per cent (1%) of acid, expressed as lactic acid.”

Forerunners of Sauerkraut

Sauerkraut is literally acid or sour cabbage and has a very ancient origin measured by standards of time as applied to food preparation and the culinary art. In the beginning it was a very different preparation from that at present. The earliest forerunner of sauerkraut consisted of fresh cabbage leaves dressed with verjuice, sour wine, or vinegar. This was before the Christian Era, and the same style of preparation was used for several centuries afterward before any other was invented and still persists in a modified form as slaw. The preparation was popular and its virtues highly extolled. It had to be used soon after preparation and was in reality a salad.

The next step in the process of evolution was to break or cut the heads into pieces, as quarters, pack them close together in casks or other suitable vessels and cover with verjuice, sour wine, or vinegar. In this case the cabbage was not used at once, but could be kept for some time and such portion removed from the container as needed. It is not known whether this method of preparation inhibited fermentation or not, but it is a fair presumption that it did not, though it may have delayed or changed the character of the fermentation, for the succeeding step consisted in adding salt to the verjuice, wine, or vinegar used in the preparation. The amount of salt was increased to such an extent that the cabbage had to be soaked before it could be used. Salt gradually replaced the sour liquid, first in excess and later in gradually less quantity, with the attendant spontaneous fermentation of the cabbage which gives the acid flavor. It is not known just when this stage of the preparation or that of cutting into fine shreds was reached as (during the Middle Ages) the history of the culinary art is very imperfect. It was probably in the fifteenth or in the early part of the sixteenth century. Neither is it known to a certainty by whom this was accomplished. It is generally attributed to the Germans, due no doubt to their great fondness for the dish and its general use rather than from his-
historical evidence. The orthography of the term is also suggestive of this, but according to one of their philologists, the term is of Latin ancestry and connects the arts with another somewhat similar food preparation, the composting of olives in salt. Some German writers ascribe a Slavic origin to it, and still others are equally certain that it was obtained from the Chinese. What seems most probable is that the modern preparation of sauerkraut is an Alsatian invention. The people of that province have been the most persistent in all Europe in refusing to be obliterated by Roman and German invasions or through domestic wars and in maintaining their customs under all conditions. They have had cabbage for centuries and all the known methods of its preparation from a dressing with verjuice to composting in wine or vinegar, and still later by preserving the broken heads with salt. Strasbourg and that vicinity have been noted as the home of the finest sauerkraut since the earliest mention of the product. But whatever the origin may have been, it has become the national dish with the Germans.

Le Thresor de Sante, published in 1607, gives what appears to be a description of the preparation of the immediate predecessor of the present style of sauerkraut. "The Germans, in order to guard against the winter, cut them (the cabbages), loosen them, make layers of them in a tub with salt, juniper berries, spice, barberry, root of pepper, consequently one layer of cabbage, and the other of these ingredients. Each layer is pressed hard for the better connection and union.

"Another way to keep them, boil them a short time in water, tearing them apart, holding them preserved in vinegar, salt, pepper, and barberry. These are eaten uncooked by the way of salad with olive oil, during the winter."

Here are two stages in the preparation associated with a definite time. The most learned writer upon foods at that period was Olivier de Serres, who does not specifically mention choucroute, but in his Le Theatre d’Agriculture is the following from the sixth edition, 1617.

"Likewise there should be for salad during the winter head cabbage and head lettuce, held white and firm in vinegar. Their green leaves, removed first, the hard white heads remain; the cabbages are cut in quarters, the lettuce only in half for large heads, the small ones are left whole; in this way the vinegar penetrates and conserves them.

"Another way to conserve cabbage heads for a long time, but to be eaten in potage, not in salad like the preceding: They are held entire for a year. A kettle full of fresh water is put on the fire; when the water boils, the cabbage despoiled of its green leaves; that is, only the white head, is plunged into the boiling water, then removed at once, is put into a large barrel or tun having one end broken in, with wine and water in equal amounts, also some ordinary yeast paste and some salt to preserve from corruption. As the heated cabbages are taken from the boiling water they are arranged closely in place without bruising, from where they are drawn as needed. A top is kept on the tun to keep them clean."

Another viewpoint concerning the history of this comestible is supplied by the eminent Russian botanist, A. Maurizio.* He states that food preser-

vation by fermentation is a primitive method used by the people of the cold
regions from the earliest habitation and is as natural to that section as dry-
ing in warm climates. Its importance decreases as one approaches the
warmer zone.

The Esquimaux, Laplanders, and others living near or within the Arctic
Circle have a very meager vegetation to draw upon and for a short time
each season. The people collect the more succulent shoots, leaves and stems,
also moss and make compost to carry them through the long winter. Brine
is used to wet the material when packing and an acid fermentation results.
In one modified type the raw materials are heated to boiling to speed the
action and when the fermentation is complete the solids are packed in rein-
deer stomachs and kept frozen until wanted for use.

All the northern races of Russia and Siberia have similar foods and
grow varieties of cabbage and lettuce adapted to the climate instead of
depending upon the wild native plants. They make holes in the ground or
use cooperage if available for holding the material during and after fer-
mentation. The heads may be cut or used whole, in the latter event they
may be passed through fire to wilt them instead of dropping them into
scalding water. They are tightly packed and covered with brine. All sorts
of vegetables and roots are treated in the same way and the odor of the
compost pits and fermentation permeates the whole village during the
harvest season. Both the solids and liquids are used. The latter most often
in soups. In the far north the fermented vegetable is practically always
used with fish or seal blubber and it is combined with meat in most other
places.

According to this view fermented foods of this type diffused south-
ward through Russia and Poland into Germany and other parts of Europe,
augmented also by methods learned from the Tartars and other northern
Asiatic tribes in their incursions into the country. Ancient occidental
Europe had little fermented vegetables other than cucumber pickles while
Russia and those other northern countries affected by oriental influence
had a wider variety and more extensive use. Even as late as the beginning
of the world war, sour whole heads of cabbage were sold in the markets
of Lemberg and Roumanian cities.

A rather distinctive manufacture of kraut occurs in Bulgaria. The whole
cabbage heads are trimmed then cut in quarters or halves, packed tightly
in a cask and covered with brine but instead of being allowed to stand,
the brine is drawn off from the bottom and poured on the top. This is
done once a day for a week to ten days, after which it is allowed to stand
and complete its fermentation.

Other plants used are watermelons, green tomatoes, apples, turnips, a
mixture of cabbage and peppers, lettuce, etc. The latter is exclusively
Polish. Cut green beans, schnittbohnen, is exclusively German. Rousset*
adds the following: “Sauerkraut from pumpkin. Very popular among the
Hungarian peasants. This is prepared by cleaning the interior and remov-
ing the rind, then it is cut into very fine slices. The slices are arranged in
some butter pots in layers sprinkled with table salt to which is added pepper
corn or juniper seed. At the end of some weeks a dish is obtained that re-
sembles in taste the sauerkraut.”

Present-day Procedure

The general procedure in the making of sauerkraut is to use cabbage with white, firm, compact heads, of the Flat Dutch type, when fully matured as the early varieties and those which are immature are almost certain to produce a product that is poor in flavor, texture, and appearance. The purple and red cabbages can be used as far as making an edible product is concerned, but the color is objectionable. It naturally follows that little sauerkraut is made before the first of September, after which manufacture continues until into December in the northern producing section.

The cabbage is harvested by cutting the heads from the stem with the aid of a sharp spade, but leaving a sufficient number of green leaves attached to afford protection. They are pitched on wagons provided with wide-open racks or beds, the handling being done by hand or by means of wooden forks. This style of fork has displaced that with steel tines for the reason that the latter are frequently used in a manner to puncture the head and thus introduce infection and subsequent rotting.

If the heads be small, about 50 per cent of the plant is left in the field, whereas if large, only 25 to 30 per cent is left.

The cabbage is not hauled directly from the field to the preparation room in the factory, as in most canning operations, but the heads are held for a sufficient time to wilt slightly, which may be as short as two or three days during a fairly warm, dry period, or as many weeks when the weather is wet and cold and the heads left outside. In some respects this delay is advantageous, as it makes harvesting easier and the factory operations steadier and with a smaller crew.

U. S. STANDARDS FOR CABBAGE FOR SAUERKRAUT MANUFACTURE (1933)
(Effective February 11, 1933)

Introduction

Grades for cabbage for sauerkraut manufacture which provide a definite basis for contracts between the manufacturer and the grower are meeting with increased favor. Such grades must recognize variations in commercial value and still be simple enough to be practical in actual operation.

Buying and selling on grade will encourage better production and better handling. The practice of paying a flat price for all cabbage which is accepted, discriminates against the best growers. The grower should be paid a suitable premium for stock of high quality which will make a high quality manufactured product. Such stock can be manufactured at a minimum cost. On the other hand there should be a suitable penalty for the delivery of culls.

It should be understood at the outset that in the application of these grades the only sorting required of the grower is the removal of Culls. Such cabbage should be left in the field. These grades provide a basis for sampling the cabbage as it is delivered to the factory and with a sufficient premium paid for U. S. No. 1 cabbage over that paid for U. S. No. 2, it will be to the advantage of the grower to increase the percentage of U. S. No. 1 cabbage and to decrease the percentage of U. S. No. 2 by careful growing and harvesting practices.

Attention is specifically called to the fact that in these grades there are no tolerances for defects. The reason for this is that the inspection report will show the exact percentages of U. S. No. 1's, U. S. No. 2's and Culls for each load. It is therefore suggested that when the grades are used as a basis for sales to distant buyers, the seller should describe the quality by quoting the percentage of each grade of cabbage in the shipment. For example, a shipper may quote "90 per cent U. S. No. 1, remainder U. S. No. 2," or "85 per cent U. S. No. 1, 2 per cent Culls, remainder U. S. No. 2" in accord-
ance with the facts. Such quotations should give the distant buyer a picture of the quality of cabbage in the shipment.

The application of these grades requires the services of private or official inspectors to determine and report the percentages of U. S. No. 1, U. S. No. 2, and Cull cabbage in each load. Such inspectors must be capable, efficient, and above all they must be absolutely neutral.

**Grades**

*U. S. No. 1* shall consist of heads of cabbage which are firm and well trimmed; which are free from seedstems, and from damage caused by bursting, decay, discoloration, freezing, disease, birds, insects, mechanical or other means. Unless otherwise specified, the weight of each head of cabbage shall be not less than 3 pounds.

*U. S. No. 2* shall consist of heads of cabbage which are not soft; which are fairly well trimmed, free from seedstems and from serious damage caused by decay, discoloration, bursting, freezing, disease, birds, insects, mechanical or other means. Unless otherwise specified, the weight of each head shall be not less than 2 pounds.

*Culls* are heads of cabbage which do not meet the requirements of either of the foregoing grades.

**Definitions of Terms**

As used in these grades:

"Well trimmed" means that the head shall be free from loose leaves and the stem shall be not longer than one-half inch. Loose leaves shall be considered those leaves which do not closely enfold the head. Heads of cabbage which show evidence of having been well trimmed in the field shall be considered as meeting the trimming requirements although they may have some leaves which have become loose in the process of ordinary handling.

"Seedstems" means those heads which have seed stalks showing or in which the formation of seed stalks has plainly begun.

"Soft" means loosely formed or lacking compactness.

"Damage" means any injury which materially affects the shipping or canning quality or which cannot be removed in the ordinary process of trimming without a waste of more than 5 per cent, by weight, over that which would occur if the head of cabbage were perfect.

"Serious damage" means any injury which severely affects the shipping or canning quality or which cannot be removed in the ordinary process of trimming without a waste of more than 15 per cent, by weight, over that which would occur if the head of cabbage were perfect.

**The Factory**

A sauerkraut factory is one of the simplest in construction and equipment connected with the food industry, requiring only a plain substantial building in which to house the fermentation tanks, provide room for wilting the cabbage, for coring, trimming, cutting, and distributing it, and also clean yards or sheds for receiving and holding the wagon loads of heads. The mechanical equipment is equally simple, a number of fermentation tanks or vats, preferably of wood, belt conveyors to carry the cabbage from the outside or from the wilting bins to the trimming tables, cutters, and finally to the tanks, or this last may be done in push carts. The coring and cutting machines are the only ones especially designed for the purpose and are neither large nor complicated. The fact that such simple equipment suffices and that the process is one of fermentation has its drawback in that it does not create a proper sense of the care needed to produce the best product. The operators, however, are learning that the so-called secondary equipment; that is, cement floors pitched for quick drainage, and ample distribution of water and steam for washing have acquired a new meaning. This is in line with the commonly accepted dictum that commercial preparations are subject to more rigid requirements than are home productions. The building needs to be well lighted, to be closed and
divided for heating when necessary, and in general to comply with the sanitary requirements of food production establishments. The size is regulated wholly by the volume which must be handled within a given time and the height dictated by the convenience in distribution of the product in the plant. There are no standard units of equipment, but each manufacturer selects that which appeals to him as best suited to his conditions. These details will be considered in connection with the various operations. If canning be done, and that is the preferable method of conservation and distribution, then additional space is needed for the packing and storage.

Receiving the Cabbage

The procedure in handling the cabbage varies in some details at the different plants, but these are of minor importance. The delivery of the cabbage may be directly into the sweating bins, especially during the season when operations are not being rushed, and thus avoid a second handling, or as more frequently happens, may be piled in long rows in the yards or spread on floors in sheds. The harvesting is regulated in part by the weather rather than by the immediate needs of the factory, and huge stacks accumulate to be drawn upon in accordance with the suitability of the heads for cutting. The weather also determines in a measure the speed with which they can be prepared for cutting. The rows are piled over A-shaped frames made from 24 to 30 inches in height and of equal width at the bottom. The depth of the heads over the frame is not permitted to exceed two feet. The frame serves for ventilation so as to prevent irregular wilting. In the case of piling on shed floors which are above the ground, the heads may be spread uniformly to a depth of a couple of feet.

Wilting

The cabbage is allowed to remain in these piles until the outer leaves show wilting, the indication that they are ready for cutting. In Germany it is customary to cover the piles with a light layer of straw so that the heating will proceed uniformly in the outer and inner layers of heads, and also for having an even temperature in the cabbage when cutting. This last factor, the equalization of temperature in the heads, is probably the more important and one that might be adopted here with profit. Some manufacturers prefer that all cabbage should go through the wilting bins so that the process may be better controlled and not depend upon that taking place in the yards, especially late in the season.

The receiving or wilting bins are arranged along an outer wall of the factory to receive the heads directly from the wagon. The bottom of the bin is given an incline to direct the heads toward the inside, cross partitions being placed at intervals to keep the different lots separated. Provision is generally made for a moderate amount of heat, depending upon how cold the heads may be or their condition as to freshness.

The object of wilting cabbage is to prepare it for cutting. If the cabbage be cut immediately after harvesting, a considerable part of the shreds will be so crisp as to break in the cutter or will break when filling into the vats. A slightly wilted cabbage can be cut into finer and longer shreds than the unwilted, and will hold together throughout the entire process of manufacture. This preliminary step is described and the object clearly stated in an unsigned article upon sauerkraut published in French sixty years
ago. P. Joigneau also in his *Les Chou* (1873), quotes a Belgian to the effect that they allowed the cabbage to wilt for eight days before cutting. Furthermore, it is indicated that the practice was not new at that time, thus disproving the current statement that it is a recent step in manufacture made necessary by the rotary disk type of cutter. P. Albert in his *Manuel Complete d’Economie Domestique* (1822), states that the cabbage was cut fresh, then allowed to stand from 12 to 24 hours before packing, which seems to have been an earlier variation with a somewhat similar object.

**Coring**

When the factory operations begin, two or more men remove the heads from the bins, quickly press the base against the coring machine and then toss them on the conveyor. This provides an opportunity to make an inspection for unsuitable heads before any work has been expended upon them and the handling necessary for coring is done before the outer leaves are removed, both of which are good features. Furthermore, it insures that every head be cored, as there is more time in which to do the work at this stage than later when the heads accumulate on the conveyor. In a late type of machine the heads are placed in large cups that automatically press the heads against the cutter and discharge them on the conveyor. Some of the outer leaves are also cut away in the same operation; the work is made easier, two men doing the work that three did in the older method. The machine itself is a special device, usually consisting of a conical, spiral cutting knife that is power driven. This slices the core in such manner that later when the head passes through the cutting machine, there will be no broad, thin pieces. In one form, the heads are laid on the conveyor belt and an electric driven coring knife mounted on a flexible arm is used, being plunged into the core as the head passes along. This style has not come into general use, but seems to be especially well suited for doing the work after the trimming, as no handling of the head is necessary. Some of the coring machines remove the core, but since that part is tender, sweet, and edible, there is little reason for discarding it when it can be shredded. It requires at least two men to core the cabbage for a cutting machine, and better work can be done by three, especially when using the older type of corers.

The details of the coring machine are given in the appendix.

**Conveyors**

The simplest conveyor system consists of a belt about sixteen inches in width running from the outside of the factory or from the wilting bins, over the trimming table to the cutting machine, the cabbage being carried first to the trimmers, and, after being trimmed, continued to the cutters, the waste being removed in the return flight. This makes the simplest possible installation considered from a mechanical point of view, but it may be open to serious criticism from the standpoint of cleanliness. The heads as they come from the field are contaminated with dust and soil, and after wilting, the surface of the leaves become sticky, so that within a short time after the conveyor is in operation it becomes gummy and with a kind not easily removed. Returning trimmed heads to such a belt means a constant addition of infection to the freshly exposed clean leaves. In removing the waste on the return flight there are always pieces of leaves dragged into the end pulley, and these are crushed and add to an unclean condition. The
use of a revolving brush across the belt at the end of the flight aids much in keeping the belt clean. Under any circumstances a second conveyor to carry the heads from the trimmers to the cutters is desirable. It should stop a couple of inches before it reaches the chute leading into the cutter, thereby permitting any bit of gravel or foreign substance to fall through and not get into the knives. This accident is infrequent, but occurs often enough to warrant taking the precaution to prevent it.

Trimming

The trimming tables are made narrow so that women working on either side can reach to the center without undue exertion. The heads are taken off the belt and all green leaves, grossly coarse leaves, or defective parts are removed and the head returned, preferably to another belt to be carried to the cutting machine. It requires from 15 to 20 women to trim cabbage so as to keep a cutter in continuous operation, and the length of the table is governed by the cutting capacity for one or two machines. If more than two machines be used, the speed of the conveyor is increased beyond the point where the best inspection can be made, and in this event additional units are preferable to increasing the length. The space allotted to each worker is about three feet. Short-bladed butcher knives are used for trimming, which amounts to about 20 per cent, though this varies with the care taken in field cutting and the condition of the crop. The waste is dropped into a chute to pass to the floor below or in some cases upon the return flight of the conveyor to be carried to a point where it can be discharged into wagons.

Washing

Recent experiments by the University of Wisconsin clearly indicate that the quality of kraut may be much improved by eliminating a greater proportion of the mixed organisms found on the outer leaves of cabbage. These are present on the plant and also obtained from the soil, dust, and air, and increase in numbers due to injuries to the leaves in harvesting and handling. The inner leaves are relatively free from these organisms, but in their place are lactic acid producing forms of the kind desired for fermenting the cabbage. By subjecting the trimmed heads to the action of strong sprays of water, surface contamination can be reduced and thus lessen the detrimental effect which might follow. The use of hot water for washing showed very little advantage over cold. The good effects in washing were due to the force of the water in reaching all exposed parts and thus getting rid of the surface organisms.

The highest percentage of fancy kraut resulted when the cabbage was washed with hot water and inoculated with selected organisms.

Cutting

The cutting machine, like the coring device, has been especially developed for the purpose. It is simple and highly efficient, consisting of a horizontal disk with a number of outwardly curving knives, so set and spaced as to cut the cabbage into thin slices of equal thickness, usually about one thirty-second of an inch. These are power driven and have large capacity, the standard size, 32 inches in diameter, being able to cut 50 tons per day. The heads, as they pass from the conveyor, are divided into two
lines to be fed in at opposite sides. Two men are required to do the feeding, or three if the heads have not been cored before trimming.

As previously indicated, the cabbage was first cut into pieces of such size that it could be closely pressed together in the cask or container, and these pieces were gradually made smaller, particularly after spontaneous fermentation became a part of the process. One of the earliest English works, *The Compleat City and Country Cook* (1736), by Charles Carter, in describing sauerkraut, says: "You must have an Engine to cut it with very fine as Vermigelly." The first cutting machines consisted of a board with a slot cut across it, generally at an angle, into which was fixed one knife, the edge of the blade projecting slightly above the level of the board. This was improved by adding more blades. The cabbage head was moved backward and forward above the blade or blades, the cut portion falling through into a tub or other receptacle. Doubtless the danger of cutting the hand while operating suggested the making of side guides and a box to hold the head. This was the approved type and used almost exclusively until 1885. Even Corthay, the leading manufacturer of apparatus for the food industries on the continent, shows only this style in 1891. The first patent issued for a cabbage cutter in this country was for one of this type, the special feature claimed for it being that the thickness of the cut could be regulated through controlling the level of the cutting edge of the knife. The patent is No. 22,636, granted to James Fraser, Rochester, New York, in 1859. One of the latest patents utilizes the same principle, but the blade is made to have a double cutting edge, so that a slice will be made on both the forward and backward movements. This is for a culinary utensil and the patent is No. 1,296,091, issued to J. S. Kriebel, East Greenville, Pennsylvania, in 1919.

The first cutter using knives mounted on a revolving disk was patented in this country in 1894 by John Rostosnik, of New York. His first machine had only a few curved blades, but provided that any number might be used. Above the disk was a bar, and a board which acted as a deflector to press the head against the knives. The high speed of the power-driven disk greatly increased the cutting capacity over the earlier type of reciprocating mechanism. Below the disk was a mechanism for feeding salt upon the shredded material. Several patents have been issued since for appliances of this kind, but these pertain particularly to details as to the shape of the blade, method of setting the blades, etc. This one has the essential features for getting both a long thin shred and capacity. In the latest modification of this type, the knives remain stationary and the head is carried around by the feeding mechanism.

The thickness of the cut is generally gauged at one thirty-second of an inch, as this gives the very fine appearance desired in the finished product. The earliest record found giving a definite thickness for the cutting is by P. Albert in *Manuel Complete d’Economie Domestique* (1822), and there the preference is for cutting between one-twelfth and one twenty-fourth of an inch. A knife with a long outward curve gives a longer shred than does one with a straight blade or a crescent blade cutting on its inner curvature. While the long, fine cut is devised primarily for appearance, a secondary effect is produced which is advantageous in that a larger number of plant cells are laid open to the action of salt and less tamping and bruising of the tissues result when filling the vats. The long-cut type of cutting ma-
chines is frequently referred to as German type cutters or Magdeburg cutters, and came into use in this country about 1903.

The cutting is most often done in an upper story of the factory or at least above the level of the fermentation vats as it is easier to elevate the heads than the cut cabbage. The shredded cabbage may be conveyed directly from the machine to the vat on a belt, or, as is more commonly done, in hand push carts. If a belt be used, then the chute at the vat is made adjustable to deliver the cabbage to any point in the tank, the object being to prevent packing where the cabbage falls. If the push cart be used, a hopper is placed under the cutter and the box on the cart made to hold a definite amount, and thus the load becomes the unit for salting. A platform is built around the top of each tank while the filling is going on in order that the cart may be dumped at different points to prevent irregularities in packing. The cart method is preferred by most manufacturers as it is the cleaner and affords a better control in salting. The salt can be added to the cabbage as it goes into the cart, or what is better is to dump and spread a definite amount of cabbage, as two hundred or five hundred pounds, and then spread a measure of salt to correspond to the weight of cabbage. This involves a little more work, but insures even spreading, treading, and distribution of both cabbage and salt.

Salting

Salting has been done at the cutting machine by a special attachment below the cutting knives, but the fact that the two leading manufacturers of the machinery do not list these attachments is pretty conclusive evidence that the method is not wholly satisfactory and that better results are obtained by hand methods after the delivery of a given weight of cabbage.

Vats

The fermentation vats are usually large, 8 feet or more in height and 12 feet or more in diameter, built of wood, bound with iron hoops, and resting upon cross pieces above a cement floor. The woods selected are generally cypress, redwood, sugar pine, or fir, kinds which neither discolor nor give off anything to affect the flavor, though as a precautionary measure they are coated with paraffine. The sizes are not standardized, but 8 feet in height and 12 feet in diameter, holding about 26 tons, was almost the only size used between 1900 and 1920, and still continues to predominate. Beginning about 1920, the size was gradually increased to 12 feet or more in height and to 16 feet or more in diameter. A 12 by 16 foot tank will hold about 70 tons. These extra size tanks have advantages for very large producers, and also disadvantages, the latter outweighing the former, so that some packers are returning to a larger number of the smaller size to handle the same capacity. Concrete vats came into use about 1914 and were highly lauded at first, but the general experience has been that they have only one point of superiority in their favor, and that is for holding kraut for a considerable time. They are cold, which may interfere with fermentation, need to be kept thoroughly coated to prevent attack by the kraut acid, and crack at most unexpected times.

When sauerkraut making was a home operation or conducted upon a small scale, the cut cabbage was filled into tubs, hogsheads, barrels, kegs, or even large crockery containers. A layer of cabbage was tamped in tightly
by means of a long-handled wooden pestle; a sprinkling of salt applied, followed by tamping, then repeating with cabbage and salt as often as might be necessary to fill nearly to the level. The pestle was applied with sufficient vigor to assure a layer of salty juice over the top. With such a variety of sizes and shapes of containers, there was lack of uniformity in the finished product. Some barrels overflowed to excess during fermentation, some leaked, others carried detrimental infection from previous usage, and still others showed the effect of irregular tamping and salting. When sauerkraut became a commercial product, it had to conform to the general requirements of all foods and other goods in that there had to be a reasonable degree of uniformity. The barrel was favored at first as that was the unit of sale to grocers, and it was neither repacked nor reshipped but delivered by wagon in the same city or town where the kraut was made. This did not suffice for long, however, and kraut was repacked in barrels and kegs, and with the repacking the juice was discarded in large measure to save weight and freight. Dry packed kraut became an article of commerce to be shipped any distance. The dry packing of kraut in kegs of from eight to twelve gallons had become standardized in Strasbourg early in the nineteenth century, the shipments exceeding 300,000 pounds annually. Small amounts were even sent to this country before local producers entered the trade.

When the stage of repacking kraut was reached in this country, it naturally followed that the making was conducted in larger units to favor uniformity and to eliminate much waste of top spoilage that occurred in the smaller containers. The credit for the introduction of larger vats, about 1885, seems to be due to H. J. Heinz, of Pittsburgh. The first vats were on the order of pickle vats, about 4 feet in height and 6 feet across. Other packers, acting independently, made tanks of various sizes, so that by 1900 the 8 by 12 foot tank, holding about 190 barrels, was considered the best that could be produced. During this period and continuing until about 1915 it was not uncommon to set the vats in the open like pickle vats. Also, during this experimental period no accounts are given as to the advantages, if any, of one type or size over another. Abroad the size of the vat has not increased as in this country, and large quantities of kraut are still made in hogsheads and barrels. Here the use of these latter has practically ceased in commercial plants.

Before being used, the vats are thoroughly soaked and cleaned, and in the case of cement, the interior is treated with a coating to prevent the acid in the fermented juice from attacking the cement. Hot paraffine is the simplest material for this purpose, but there are especially prepared paints that are more durable. A primary precaution is that the foundation be strong, for a filled vat carries great weight. Any sinking may cause a leak, which at times cannot be stopped, resulting in the loss of the entire content. At the better plants the tanks are set above concrete floors, the latter being pitched for drainage due to overflow, from scrubbing the inside, or hosing the outside.

Filling the Vats

The filling of the vat needs to be done with much care so that the cabbage be uniformly distributed and packed and the proper amount of salt be added at such short intervals that all the cabbage receive an equal share.
The cabbage was tamped with considerable vigor when the small containers were used, and the same process was thought to be necessary when the large vats were adopted. Two or three men were kept walking over the cabbage during the entire time of filling. Experience has shown this procedure to be unnecessary, and now the treading is limited to only that which is needed to insure an even distribution of the cabbage in thin layers, so that one man can easily fill a tank 12 feet in diameter. Attention was also drawn to the fact when fine cutting came into vogue that the best results could be obtained by close packing of the cabbage without tamping. A combination of fine cutting with only sufficient packing to start the brine gives a final product with a higher percentage of solids upon draining. This accounts in part at least for the discrepancy in the percentage of juice formerly made compared with that at present. No experiments have been reported covering this particular point, but it is a reasonable deduction from other data. Rubber boots are provided for those who fill the vats and these are not worn for any other purpose.

A vat 8 feet in depth is considered full when the cabbage is within 4 inches of the top, though upon this point there is some difference in practice, some filling to the level or even two inches above. If the vat is to be emptied as soon as the active fermentation is completed, it can be more nearly filled than if it is to stand for some time. The top may be covered with a couple of layers of white leaves or a cloth as a protective measure, or the cover planks may be laid directly upon the cut cabbage. The planks are laid close together and weighted with rock to prevent the cabbage from rising in the early stages of fermentation. Any kind of clean rock may be used except limestone. As a matter of convenience, cylinders are made of cement with an iron pipe running through the center for lifting or rolling them into place on strips above the planks. The weight on a tank 12 feet in diameter needs to be about 3,500 pounds, and on a 16-foot tank about 6,000 pounds. Another scheme for holding the cover is to put uprights outside the tanks with crossbars over the planks secured by wedges. This latter is the usual method for keeping pickles submerged.

The juice, formed by the action of the salt upon the cabbage and the close compression, soon rises above the cover, and if it fails to do so within eight hours, sufficient water may be turned on to make a covering. The cabbage tends to rise in the early stage of fermentation and exerts considerable force, so that if insufficient weight be used or the blocking be weak, the top will be forced off and an overflow result. If the cover be secure, the brine will rise above it to the top of the vat, and when fermentation is completed, the solids will sink to the bottom.

**Temperature of the Cabbage**

If the cabbage be fairly warm, that is, about 70° F., or above, it is placed directly into the fermentation vats, but if it be below this point, and particularly if below 60° F., it is advantageous to warm the cabbage so as to favor prompt fermentation. One method is to store the cabbage in a warm wilting bin at 85° F., or above, for a day or more. This is not entirely satisfactory, as heat penetration in a cold head is slow under such conditions and prolonged storage favors the development of putrefactive organisms on the outer cut surfaces. Another method which has met with some favor is to subject the cut cabbage, as it leaves the machine, to a brief exposure
to steam. This was first carried out in a factory by J. J. Anderson, of Salt Lake City, in the fall of 1918. A pipe was bent into a circular form and perforated on the inside so that steam was directed upon the cut cabbage as it fell into the cart. The cabbage was heated uniformly to the desired degree, but none to excess. Mr. Anderson heated his cabbage to 70° F., and also kept the vat room at the same temperature, with a resulting moderately quick, complete fermentation. Still another scheme with a similar object is to box over a section of the conveyor belt leading from the cutting machine, and to provide overhead perforated steam pipes to direct the steam against the cabbage passing on the belt. This is capable of closer control than the previously described method. The condensation from the steam is so small that no injurious results have been reported, though the salt content needs to be increased about 10 per cent. One of the most successful kraut packers has obtained his best quality of kraut when packed at from 68° to 70°, but never of equally good quality when steam was used for heating the cut cabbage.

Fermentation

The Bureau of Chemistry determined the conditions for optimum growth of the bacteria which cause the fermentation in sauerkraut, and found the temperature to be 86° F., and recommended that the cabbage be raised to near that point at the time of packing in the vat. That was in 1919. The best sauerkraut made abroad, however, is packed at a lower temperature, from 68° to 70°, which is preferred to rapid fermentation, and lower than this for the best quality. The practical experience of the better packers here and recent experiments at the University of Wisconsin are in accord with the Europeans upon this point. In their experiments, a range of temperature between 60° and 66° F. gave the best results in the quality of the product. As in the case of some other fermentations, for example, wine and bread, the formation of those by-products which affect flavor most favorably does not proceed in the same ratio as optimum growth of the lactic acid organisms, and of the two factors, time of fermentation and quality in the product, the latter is the more important to the consumer. Active fermentation is said to be complete in from 7 to 8 days at 85° to 86°; in from 10 to 12 days at 80°; in 14 to 18 days at 75°; and in 18 to 25 days at 68° to 70°. The fermentation may follow a nearly normal course, as low as 45°, but proceeds very slowly. Cabbage which is very cold, near freezing, will be delayed a long time, as that packed in December may not ferment until the following May, and then, though the fermentation may be normal, such delayed activity is attended with risks and is usually unsatisfactory. The conductivity of heat in cut cabbage is extremely poor, so that it is impractical to apply heat on the outside of large vats to start fermentation. When barrels and small casks were used, it was customary among the French to hold them, if cold, in a very warm room until active fermentation was completed, and then to move them into a cold cellar. Recent experimental work at Wisconsin has shown that cabbage packed at a temperature too low to start fermentation and held at low temperature during the winter did not ferment in a normal manner, but decomposed with the rise of temperature in the spring.

Peterson and his associates found that the fermenting organisms function through a wide range of temperature, also that there is a slight rise
in temperature in the materials as a result of this activity, but not so marked as in the case of like changes in silage.

The quick fermentation is desired in order that the vats may be used from two to four times during a season. The fermentation is considered complete when visible activity has ceased and the acidity has reached about 1.8 per cent acid, calculated as lactic acid. Abroad, the very rapid fermentation is not favored, and new kraut, that is, just after the activity has ceased, is looked upon in the same way as new wine at the moment working ceases; that is, as wine but not fit for drinking. In the case of sauerkraut, they consider twenty days as about the minimum time before using, that from forty to forty-five days is much better, and that ninety days are really needed to get the changes other than those due to acid fermentation, but which affect the flavor. These two objectives are so far apart that it does not seem possible to compromise the differences, at least not until more information is available.

Salt

Experience indicates that the salt content should not go much below 2 per cent nor above 3 per cent; that if less than 2 per cent be used, the sauerkraut is likely to be slimy as the result of the activity of undesirable forms of organisms, and if above 3 per cent, often pinkish in color, with low acidity, and possibly a disagreeably salty taste. Two and one-half per cent is the happy medium for which most packers strive, a little more for cabbage if warm, or if steam be used to heat it, and a little less if the fermentation takes place when cool. Salt has a double function, one to act upon the cells to abstract juices to form brine, and the other to control the fermentation by inhibiting the growth of other organisms while the lactic acid forms are gaining the ascendancy. The juice from the cabbage contains some soluble solids so that, according to Le Fevre, the brine formed from the addition of 2½ per cent of salt will test very closely to 17 degrees upon the salinometer, and any variations above or below this figure will bear a close relationship to the amount of salt used. Fine table or dairy salt is the grade selected.

The Germans and Dutch use a lesser amount of salt, preferably 1.5 to 1.75 per cent, the smaller amount being used when the temperature is under 50°F. They favor the slower fermentation at the low temperature with a total acidity of only 1.25 to 1.5 per cent and claim that the distinctive flavor is more pronounced under these conditions. Whether the flavor is due to the use of less salt and the formation of less acid or due to the better development of the flavoring principles is not clear. The French also favor an acidity of about 1.25 per cent.

Other Flavoring

The addition of flavoring is common abroad, going back to the very beginning of kraut making. The products of certain houses have acquired high repute, due to the effects thus obtained. The principal ingredients used are juniper berries, barberries, pepper, cumin, caraway seed, and dill. In Germany, sliced apples are frequently added, and in Italy the inside of the cask may be rubbed with garlic. The practice has not come into vogue here.
Fermentation in the Vat

When the cabbage is covered with the planks and a layer of juice, froth soon begins to appear upon the surface, due to escaping gas and entrained air from the compacted mass. A part of the gas has been ascribed to respiration from the plant tissues during the first three or four days, but the latest work seems to cast some doubt upon this point. Doubtless some of the gas is due to the activity of gas-producing organisms at first, but which are soon checked by the changed conditions induced by the lactic acid forms. The principal fermentation is due to these latter organisms which are normally present in large numbers on the leaves. The cutting of the cells and the action of the salt liberates plant juice with its food material suitable for immediate use by the bacteria. Little gas is produced and only a slight rise in temperature as compared with that which takes place in non-salted silage. The action in the cabbage goes on in the absence of oxygen and is remarkably uniform from top to bottom and in all parts of the vat when one considers how poor the circulation of the brine must be. The organisms increase rapidly if the temperature be favorable with a rise in acidity to about 1.75 to 1.80 per cent. Theoretically, the acid should equal about one-half the sugar content, which averages about 4 per cent, but the fermentation rarely proceeds to the point of exhausting all the sugar. If the fermentation proceeds at a temperature below 60°, the acidity is less or about 1.25 to 1.40 per cent, accompanied by an increase of other products which cannot be so readily determined by chemical methods.

In the earliest stages of fermentation, a certain amount of activity is due to mixed organisms, and among them are some yeasts, the small amount of alcohol found being assumed by the first investigators to be due to them, but again the more recent work shows that this may be due to the lactic acid forms. These are normally so much more abundant than other forms and are so active under the conditions that they gain the ascendancy and soon inhibit the growth of other organisms by reason of the increase in acidity, and they probably destroy them also by changes they produce in the medium. After a few days the flora changes suddenly and the non-lactic acid producing forms nearly disappear.

At the close of the active fermentation there is a sudden drop in the number of all organisms, due apparently to destruction from the products of their own metabolism, so that the finished product contains few living organisms.

Protecting the Top

When the fermentation is complete and the solids have settled, the top is cleared of all foam and scum, and if there be an insufficiency of juice to cover, water is added and then the surface sealed with a layer of tasteless mineral oil. This is especially desirable if the sauerkraut is to remain in the vat for some time as organisms of various kinds are borne in the air which, falling into the brine, start growth and reduce acidity. The lactic acid serves as food for some of these air-borne forms and by excluding them or making the conditions unfavorable for growth the sauerkraut may be kept in good condition for months. The use of oil for covering as protection and to prevent evaporation, though not mineral oil, has been known and practiced for more than two centuries.
Starters

Since butter and cheese making, or at least in some forms of their manufacture, are dependent upon lactic acid changes in the milk and are greatly aided by the use of pure cultures or starters, it was assumed by some that the same technique applied to the manufacture of sauerkraut might yield equally good results. This was supported in a measure by an empirical practice which started long before starters were known. It was to the effect that the inside of barrels or casks be rubbed with good sauerkraut or juice from good sauerkraut before filling with new cabbage, and to use barrels in which good wine or good vinegar had been stored but to avoid any barrel or cask in which kraut had spoiled. Other packers believed that the normal flora on the cabbage was of the proper kind and quantity to give the desired result if the other factors were made favorable for their growth.

Experiments with the use of cultures were begun about 1910 with varying results, as might be expected from pioneer work and especially when conducted in the crude manner of the time. The first commercial test in this country seems to have been made by the J. T. Polk Co., Greenwood, Indiana, in the season of 1914 and 1915 when the work was interrupted by the war as the cultures were obtained from abroad. Ten years later, Brunkow, Peterson, and Fred at the University of Wisconsin, demonstrated that inoculation of cut cabbage by the proper strains of organisms yielded a superior kraut with a higher lactic acid content and a lesser acetic acid and ethyl alcohol content. They used a strain of *Streptococcus lactis*.

Subsequent experiments have shown that spraying the trimmed cabbage under a strong pressure of water just prior to cutting gets rid of most of the adventitious forms of soil bacteria. This leaves the lactic acid forms, which are present in the interior of the head, so greatly in the ascendency that they dominate the fermentation from the beginning. It is a practical method of securing an improvement in quality and greater uniformity at very little expense.

Solids in Sauerkraut

When sauerkraut was made in the barrel and delivered to the grocer, it was approximately 60 to 65 per cent solids and 40 to 35 per cent liquid or brine, according to the figures given in the older trade journals. Whether handled locally or in shipment, there was a large excess of unsalable waste. When the larger vats first came into use, the proportion of solids to liquid rose appreciably, being given as from 70 to 75 per cent and the juice as 30 to 25 per cent, and this has since changed to 80 to 85 per cent for the solids and 20 to 15 per cent for the brine. No explanation was given for the difference in the ratios at first other than that it might be due to lesser surface spoilage, differences in overflow of brine, etc., whereas some of this seems to be connected with the difference in cutting and much less tamping, so that the juice remains in the tissues, and also to prompt removal from the vat as soon as the active fermentation is completed.

Bulk Distribution

Vat production of kraut effected economies through repacking in kegs or barrels, consisting of about 90 per cent solids and 10 per cent juice, known as dry pack, and by this procedure to save on cooperage, weight in
handling, and in the cost of freight. The new crop could be packed in the barrels soon after the active fermentation was over and the cure continue in the barrel, though the better practice is not to repack until immediately before shipment is to be made. The method of distribution was a marked improvement over that which preceded, but still lacked much of being perfect. Infection frequently occurred in the handling, sometimes the kraut became brown, pink, or slimy, and spoiled after the barrel was opened, not to mention such minor accidents as leakage, blowing up, etc. Though still in use, the proportion so marketed has declined to less than 30 per cent of the total.

**Sauerkraut in Cans**

Sauerkraut being perishable after being exposed or removed from its own juice, its use was largely limited to a few cool months in the year. The next step was to find a better means for conserving the finished product and distributing it in quantities suited to the consumer at any time when wanted. Canning most nearly fulfills these conditions. It was first carried out in France, not as plain sauerkraut, but prepared, as is their custom, for the table, with meat, goose, wild goose, pork or sausage. Samples obtained not long since show the same style to be in vogue and plain kraut as well. Their literature does not show the exact time when the canned article came upon the market, but it seems to have been in the '70's.

The canning of kraut was started in this country by Peter Hohenadel, of Prairie du Chien, Wisconsin, in 1888. The experimental packing and preliminary trials in shipment improved and progressed so that considerable shipments were made in 1895. During this latter year, I. V. Smith, of Winamac, Indiana, began packing, and continued to do so for thirty-five years. The Reber Preserving Co., of Chicago, began at nearly the same time, and a year or two later the Webster Preserving Co., Webster, New York, followed, and by 1900 canned kraut became a common article among canned foods. The pack reached its peak in 1929 at 4,224,114 cases, but returned to 3,329,766 in 1933.

Sauerkraut intended for canning needs to be well cured, as no changes can take place after it is once cooked in the can. The principal criticism against this style of packing is that the cabbage is sour but lacking in those flavors which give the real value to the product. In the endeavor to use the vats several times during a season, the fermentation is hurried by heating the cabbage and the product removed from the vat soon after active fermentation is completed, as measured by the acidity test, forgetting that the palate makes distinctions not possible to titration. Some of the better packers recognize the time element in securing a proper cure and provide tanks accordingly, rather than attempt to refill at short intervals.

**Opening the Vat**

The vat is opened by first removing the weights or blocking, then flushing and siphoning off all the juice above the boards. The planks are taken up, and if the cabbage has been well covered at all times, there will be practically no waste. If, however, the brine has covered only lightly or has receded below the surface, there will be a layer of varying thickness more or less discolored, which may be slimy and need to be discarded. After sound kraut has been reached, then the spigot at the bottom is opened to
draw off the juice ahead of the removal of the solids. Ordinarlly the wast-
age in packing large vats is small. Some juice was canned as a drink, but
the fad has passed.

Canning

Sauerkraut is one of the easiest products to can, as far as keeping is
concerned, and only a small amount of the simplest factory equipment is
needed. Low cost of packaging is further favored by the fact that it comes
late in the season, when labor is plentiful. These factors have aided ma-
terially in changing the method of distribution from bulk to cans.

Kraut is taken from the vats with forks and handled in heavy tubs or
half-barrels in distributing it to the canning tables. In some of the more
recent plants, conveyors have been installed for this purpose. The kraut is
broken apart by hand, allowed to drain, filled into cans, brine added, and
then given a long exhaust to insure heating to 145° F. or more. Another
simple installation is to use the rotary hand-filling tables, at which five or
six women break the kraut apart and fill the cans as they travel under the
protecting cover. The method may be modified by breaking the kraut
apart and then heating it in a bath of its own juice to a temperature of
about 110° F., then passing it to the tables for filling, brining, exhausting,
etc. There is little preference as to methods, provided they be carried out
with equal care. If the filling be done cold, then a long exhaust is desirable,
as the heat conduction in the can is slow and irregular. If the pre-heating
be carried to about 110°, then brine can be added at 165° or above and no
exhausting is necessary; otherwise a short exhaust suffices. The juice from
sauerkraut is very corrosive in its effect upon the exhaust box, so that
packers are trying to eliminate that operation. In 1923 a special machine
was developed for filling kraut hot, thus avoiding hand labor, and experi-
ence has shown that it can be operated at such a degree that subsequent
processing is unnecessary. However, prudence dictates that a short cook
be given to protect from infection from cans. These filling machines have
been perfected to do the work with accuracy, and a matter of economics
alone will determine which will be followed, hand or machine filling.

Hand-filled cans are weighed before the brine is added so that the solids
exceed by a slight amount the cut-out weight called for under the Food
and Drugs Regulations. Well-matured kraut makes almost no change in
weight upon canning, but very fresh material loses a half-ounce or more
in a No. 2½ can, though the can may appear to be fuller. Fresh kraut has
a more fluffy appearance than the mature. The kraut solids carry such a
quantity of salt and acids that plain hot water suffices instead of juice.

It is best that the temperature in the center of the can be above 140°
before closing to insure against springers or flippers in the event the
product is held longer than expected or is sent to a hot climate.

Cooking

Sauerkraut requires only a light cook, as it is an acid product, and when
well cured has a low bacterial content, and furthermore, the forms present
have only a slight heat resistance. The real difficulty is from irregular heat
penetration due to the fill required and to the material not being well broken
apart before being placed in the can. In 1925, Le Fevre gave the death
point for the lactic organisms concerned as 130° F., and 150° as sufficient
for sterilization. In factory operation, however, it has been found necessary to use higher temperatures, as other organisms are introduced in the handling from the vats and in the cannery. At present, it is usual to cook at 212° F. for 35 minutes' standing, or 10 minutes at 190° in the agitating cooker for both No. 2½ and No. 3 cans, and for 45 to 50 minutes standing or 15 minutes in the agitating cooker for the No. 10 can. The French and Germans both cook their sauerkraut well, as it can stand as long a period as desired. The very short cook is advocated by those who desire to conserve the maximum of vitamins.

Cooling

It is better that the sauerkraut be thoroughly cooled after cooking, as the cooling conserves color, prevents softening, and lessens the chances for the development of springers. The lactic acid attacks metal and causes hydrogen swells if the cans be kept too warm or for a long time. These are harmless, but since they cannot be distinguished by the consumer from swells due to decomposition, they are not merchantable. Good exhausting, quick cooking, and prompt cooling eliminate nearly all troubles.

Standards

The first packing was done in hole and cap cans, the fill was made to be 50 per cent sauerkraut and 50 per cent brine, which was the accepted fill until 1906. The No. 3 can was used almost exclusively, only a few No. 2½ cans being used before the war. In 1918, the Food Administration ruled that only the No. 3 can might be used for the smaller size, and also that it should contain not less than 28 ounces of solids. Shortly after the war a change was made in favor of the No. 2½ can.

The first attempt at standardization of canned sauerkraut was taken by the National Kraut Packers Association in 1909. The preamble and resolution were as follows: "It being a well-established fact that some canners of sauerkraut are packing slack-filled cans of kraut (some as low as 14 ounces of kraut to a standard No. 3 can) and offering it to the trade at low prices, and which is being offered to the consumer at the same price as solid-packed cans; namely, 10 cents per can, realizing that this practice has a tendency to reduce the consumption of this article, besides lowering its value; and further that it is desirable and necessary to establish a standard for canned kraut, the same as for other vegetables, and that this standard be a high one."

TENTATIVE UNITED STATES STANDARDS FOR GRADES OF CANNED SAUERKRAUT

February 8, 1933

Definition

Canned sauerkraut is the product obtained by the full fermentation of sound, clean, shredded cabbage to which salt has been added, contains not less than 1 per cent of acid expressed as lactic, packed in hermetically sealed containers, and sterilized by heat.

*The method of titration used to determine the degree of lactic acidity in sauerkraut is as follows: Place 10 cc. of sauerkraut juice in a flask, add 40 cc. of distilled water (hydrant water contains large quantities of alkaline salts which tend to neutralize the sauerkraut acid before titration takes place). Shake the flask to mix thoroughly the sauerkraut juice and water. Add 3 or 4 drops of phenolphthalein solution. Into this mixture slowly run, drop by drop, from a burette graduated in 1/10 cc. and filled with 1/9 normal solution of sodium hydroxide, enough of the sodium hydroxide to bring a permanent pink tint to the sauerkraut juice solution, shaking the flask as the sodium hydroxide is added. As soon as the pink tint becomes permanent (at first it will fade away) note the amount of the hydroxide used, divide this number by 10, and the result is a number which is the percentage of lactic acid in the sauerkraut juice.—Le Fevre.
APPERTIZING

465

GRADES OF CANNED SAUERKRAUT

U. S. Grade A (first quality) canned sauerkraut is of a light straw color; with the shreds uniformly cut to approximately \( \frac{3}{8} \) inch in thickness. The product is practically free from defects and blemishes; is of firm, fine texture; possesses a well developed typical characteristic sauerkraut flavor; and scores not less than 85 points when scored according to the scoring system outlined herein.

U. S. Grade C (second quality)* canned sauerkraut may have a variable straw color; the shreds may lack uniformity of thickness. The product is reasonably free from defects and blemishes; is of reasonably firm, fine texture; possesses a good characteristic sauerkraut flavor; and scores not less than 70 points and need not score more than 84 points when scored according to the scoring system outlined herein.

Off-Grade (substandard) canned sauerkraut is canned sauerkraut that fails to meet the requirements of the foregoing grades or when any one of the grading factors falls in the subdivision D.

Note.—Sauerkraut of this grade is of questionable merchantable value and no receipt may be issued for such sauerkraut when stored in warehouses licensed under the United States Warehouse Act.

PREREQUISITES TO GRADING

Condition of Container

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents, and the ends shall be flat or concave.

Condition of Package and Label

If cased, the canned sauerkraut shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Federal Food and Drugs Act.

Fill of Container

Cans of sauerkraut will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned sauerkraut that does not meet the above requirements shall bear the legend,

“Below U. S. Standard”
“Slack Fill”

A certificate of grade covering canned sauerkraut that does not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,

“Below U. S. Standard—Slack Fill”
“Contains Excess Added Liquid”

Note.—Certificates of grade issued under the United States Warehouse Act or the Farm Products Grading Law covering canned sauerkraut that does not meet the above “fill” requirement shall bear legends similar to the above in the space for “Remarks.”

The maximum head space and the minimum net drained weight allowable in the sizes commonly used in packing sauerkraut are shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can size</th>
<th>Maximum Capacity in Water at 68° F. (in ounces)</th>
<th>Net Dr. Wt. (in ounces)</th>
<th>Maximum Head Space Allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 95</td>
<td>17.79</td>
<td>14</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>16.70</td>
<td>13</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 300</td>
<td>15.22</td>
<td>12</td>
<td>9.5</td>
</tr>
<tr>
<td>No. 303</td>
<td>16.88</td>
<td>13</td>
<td>9.4</td>
</tr>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>16</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 2½</td>
<td>29.79</td>
<td>23</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 3</td>
<td>35.08</td>
<td>27</td>
<td>10.2</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>80</td>
<td>13.6</td>
</tr>
</tbody>
</table>

*Sauerkraut is usually packed in only two recognized grades—U. S. Grade A (first quality) being the highest, and U. S. Grade C (second quality) being the second grade in this commodity.
The grades of canned sauerkraut may be ascertained by considering the following factors: Color, cut, absence of defects, crispness, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
<th>I. Color</th>
<th>II. Cut</th>
<th>III. Absence of Defects</th>
<th>IV. Crispness</th>
<th>V. Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ascertain the Rating of Each Factor**

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means 12, 13, and 14.

**I. Color.**

(A) Sauerkraut that possesses a color ranging from light cream to a very light straw color may be given a credit of 13 to 15 points.

(C) If the sauerkraut possesses a dark straw color, is green, yellowish, or possesses a tint of light brown, a credit of 10 to 12 points may be allowed. Sauerkraut that falls in this classification shall not be graded above U. S. Grade C, or second quality, regardless of the total score for the product.

(D) If the color is decidedly dark, or with a pink tint, a credit within the range of 0 to 9 points may be allowed.

**II. Cut.**

(A) If the shreds of sauerkraut are uniformly cut to approximately ½ inch in thickness and are of a reasonable length, a credit of 13 to 15 points may be allowed for this factor.

(C) If the cut is very irregular, being "choppy" and poorly cut, a credit of 10 to 12 points may be allowed.

(D) Sauerkraut that is very uneven in cut, containing decidedly thick or short shreds, may be given a credit of not more than 9 points.

**III. Absence of Defects.** The factor of absence of defects refers to defects such as large pieces of leaves, dead leaves, large pieces of core, spotted shreds, or other defects.

(A) Sauerkraut that is practically free from the defects mentioned may be given a credit of 9 to 10 points for this factor.

(C) If the product is reasonably free from the defects mentioned, it may be given a credit of 6 to 8 points.

(D) If pieces of dead leaves, large pieces of core, spotted shreds, or any similar blemishes are prominently present to the extent of injuring the appearance of the product, a credit within the range of 0 to 5 points may be allowed.

**IV. Crispness.** The factor of crispness refers to the condition of the product and the tendency of the shreds to be firm, fresh, brittle, and easy to cut, as contrasted to soft or mushy.

(A) Sauerkraut that is firm and crisp may receive a credit of 13 to 15 points for this factor.

(C) If the product is somewhat tough, it may be given a credit of 10 to 12 points. Sauerkraut that falls in this classification shall not be graded above U. S. Grade C, or second quality, regardless of the total score for the product.

(D) If the sauerkraut is tough, or contrariwise, is soft and mushy, a credit within the range of 0 to 9 points may be allowed.

**V. Flavor.**

(A) Sauerkraut that has a highly acid (expressed as lactic), palatable, clean, typically characteristic sauerkraut flavor, may be given a credit of 40 to 45 points for this factor.
APPERTIZING

(C) If the product possesses a good sauerkraut flavor that may be suggestive of improper bacterial action, but not markedly so, it may be given a credit of 34 to 39 points. Sauerkraut that falls in this classification shall not be graded above U. S. Grade C, or second quality, regardless of the total score for the product.

(D) If the flavor is poor and unpalatable from any cause (acetic, butyric, yeasty, moldy, very salty, bitter, stale, or rancid), a credit within the range of 0 to 33 points may be allowed.

S. R. A. 319. Weight of Sauerkraut in Cans of Various Sizes.

Investigations have shown that properly filled cans should yield at least the following drained weight of sauerkraut, the weight being determined in each instance by draining for 2 minutes on an \( \frac{3}{8} \)-inch mesh screen:

- No. 2, \( \frac{3}{8} \) by \( \frac{3}{16} \) inch sanitary, and \( \frac{3}{8} \) by \( \frac{3}{8} \) inch hole and cap (16 ounces), 1 pound.
- No. 2\( \frac{1}{4} \), \( \frac{3}{8} \) by \( \frac{3}{16} \) inch sanitary, and 4 by \( \frac{3}{4} \) inch hole and cap (23 ounces), 1 pound, 7 ounces.
- No. 3, \( \frac{3}{4} \) by \( \frac{3}{8} \) inch sanitary, and \( \frac{3}{4} \) by \( \frac{3}{8} \) inch hole and cap (27 ounces), 1 pound, 11 ounces.
- No. 10, \( \frac{3}{4} \) by 7 inch sanitary, and 6\( \frac{3}{4} \) by \( \frac{3}{4} \) inch hole and cap (80 ounces), 5 pounds.

A can of a size not mentioned here should yield a drained weight which bears the same relation to the drained weight indicated for the can nearest in size as that existing between the capacities of the cans in question.

All cans should be packed with the maximum amount of sauerkraut which is consistent with the maintenance of quality, and the cut-out weight mentioned in the preceding list should be exceeded whenever this is possible without impairment of quality.

In making declarations under the net weight requirement of the Federal Food and Drugs Act, the total weight of the contents of the can, liquid included, should be declared.

A French Variation

An examination of a sample of French canned choucroute shows a variation of more than usual interest. The product was bright, finely cut, tender, and the flavor differed from the ordinary. Before canning, the solids had been well drained and after placing in the can the interstices had been filled with white wine. The directions upon the label were to the effect to heat the can in a pot of boiling water for 50 minutes, then open and serve with proper accompaniments, as sausage, at once. By heating in the can no odors escape about the house, and thus one of the objections to serving in the home is overcome. Care is necessary in opening the hot can in order to avoid a possible burn.

Sauerkraut Juice

Since it has been found that the kraut shares with cabbage in being an exceptional source of vitamins and that these as well as extractives are also present in the juice, the latter is being saved and used either upon physicians' prescriptions or by persons who know of its value through general reading. A brisk demand was created about 1925, but at no time exceeded the supply and has largely passed as a fad.

Juice for preserving should preferably be from thoroughly cured kraut, that which has stood forty-five days or more, as the juice taken immediately after fermentation is prone to change in color and flavor. That which is above the kraut is unsuitable for use under any condition and is flushed or siphoned off as waste. That which is below the sauerkraut is drawn off through openings near the bottom of the vat. The particles and bits of cab-
bague are filtered out, though the juice is not subjected to pressure in filtering to make it clear. It is handled as quickly as possible so as to have the minimum exposure to the air. A long exhaust, from 12 to 15 minutes, at 150°, is given in order to remove all gas which may be present, and a short cook, 8 minutes, at 185°, in an agitating cooker, is sufficient to sterilize. The same precautions are necessary if the packing be done in glass, but in addition the bottle needs to be filled as nearly full as possible. Half-pints and pints are pasteurized at 185° for 25 minutes. This method is not wholly satisfactory, but answers fairly well.

Label Weights

Liquid measure. 8Z Short, 7 ozs.; 8Z Tall, 7¼ ozs.; Picnic—No. 1 East, 9½ ozs.; No. 300, 13½ ozs.; No. 1 Tall, 15 ozs.; No. 303, 15 ozs.; No. 2, 1 pt. 2 ozs.; No. 2½, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; No. 10, 3 qts.

The amount of juice which can be saved in this way will vary from 8 to 15 per cent of the total product.

According to Roy Irons, Secretary of the National Kraut Packers Association, the first commercial packing of juice was made by the Fremont Kraut Company, Fremont, Ohio, March 15, 1922.

Scientific Investigations

The making of sauerkraut has received its proportion of scientific study recently and usually reference is made only to such investigations as have been made within the past thirty-five years, but the following account, written by the French chemist and food expert, J. B. Fournier, early in the last century, deserves to be considered. This occurs in his "Essai sur la preparation, la conservation, la fabrication des substances alimentaires," 1818:

"The cabbage from Strasbourg or from Germany is used in the preparation of sauer-kraut, in German, or saur-kront in English; which can be called chou-aigre; that is, inappropriately choucroute in French. This is the best way of making sauer-kraut; it has been served by Captain Cook on a succession of his voyages.

"The heads of cabbage are taken and cut and then placed in a kind of frame, that is advanced gradually on a machine like that used for cutting cucumbers into slices. The iron blades that cut the cabbage into slices are from 12 to 18 inches in length. While the frame is drawn forward and backward on this machine, the cabbage must be pressed gently and new ones put in from time to time. The cabbages are cut into fine slices and fall through openings in the machine. Some persons put salt and caraway seed among the slices, and others salt and juniper berries. It is packed into a tun or cask, the top being off, until juice is formed. The instrument used for this is a large stick about 5 or 6 inches in diameter or a large and strong butter beetle. The caraway seed are preferable to the juniper; in fact, they are very nutritive; and all the Tartary Nations, after grinding them, cook them with milk or fruits; besides they give, through fermentation, a greater quantity of carbonic acid. They have the property of restoring milk to nurses who have it no more and these latter qualities will alone suffice for giving preference over the juniper.

"If the cask in which the saur-kront is prepared, contained wine, brandy, or vinegar, the fermentation succeeds better, and imparts to the saur-kront
a more vinous taste. Sometimes the interior of the tun is rubbed with yeast from saur-krout, so as to accelerate the fermentation; but this precaution can be omitted if there be enough time for the cabbage to pass through a gradual fermentation. Afterwards the tun is placed in a moderate temperature, and if possible at more than 30°, Reaumur (Room with air temperature at 100° F.). This temperature hastens considerably the vinous fermentation. As soon as the saur-krout begins to be acidified, which occurs in 10, 12, or 14 days, according to the degree of heat in which the tun is held, it can be removed to the cellar for storage.

"At the beginning, a certain quantity of juice is found on top of the cabbage in fermentation, and with a stick a hole is made in the middle of the tun so that the liquor will circulate better. If the cabbage be intended for a long sea voyage, it is removed from its juice; and when in this condition of dryness, it is filled into other small casks, where it is compressed; but if it be consumed on the place, a well-fitting cover is put on top, on which a heavy weight is placed to compress the fermented cabbage. This preparation, much sought after in Germany, Denmark, Sweden, and Russia, is scarcely known in the north of France; much use is made of it in Flanders, Alsace, and Lorraine."

Recent Investigations

The more recent studies upon sauerkraut, those usually referred to as the scientific studies, begin with the work of Conrad\(^1\) in Germany in 1897. He made a number of experiments to determine the nature of the fermentation and concluded that it was due to bacteria, and gave a description of a form which he believed to be the responsible agent. The bacteriological methods in use at that time were so imperfect that no one can be certain from his description just what form he isolated.

In 1903 and 1905, Wehmer,\(^2\) also of Germany, made a more comprehensive study of the manufacture of sauerkraut and came to the conclusion that the fermentation was due to two types of organisms, the initial stage being induced by a yeast followed by an acid producing organism of the bacterial type. The yeast prepared the material for the bacteria. He gave such incomplete descriptions of the organisms which he isolated that later workers have been unable to identify them. During this same time, 1904, Butjagin\(^3\) described the successive changes in the flora in kraut from the time the cut cabbage goes into a vat until fermentation ceases. He identified two forms to which he attributed the changes. Nothing very practical was developed by these three workers and the chief interest in the results lies in the fact that it was an attempt to get at the exact facts.

In 1916, Henneberg\(^4\) studied sauerkraut fermentation and described a number of organisms which were present or concerned to a greater or lesser degree in the different stages. The technique had been greatly improved by this time, so that his work can be repeated and the forms identified.

Work on sauerkraut was begun by the Bureau of Chemistry in 1915 and the following years, Round presented two papers at the annual meet-

---

\(^5\) Henneberg, 2. 1916. Das Sauerkraut.
APPERTIZING

ings of the National Canners Association. In the first paper he advocated the control of the temperature in the vats and the use of pure culture starters as steps to improve the fermentation, and in the second, stressed the importance of factory sanitation in the better control of the fermentation.

The work was then taken up by E. E. Le Fevre, who later presented the papers which are listed below. He determined the temperature for the optimum growth of the lactic acid organisms concerned, which he found to be about 80° F.; then advocated warming the cabbage to 80° or above to get a quick fermentation, and this admonition has been repeated. In 1918, he used starters in some experiments at Phelps, New York, and obtained good results.

By far the most important experimental work upon the manufacture of sauerkraut was that started at the Wisconsin Agricultural Experiment Station in 1921 by Peterson and his co-workers, and which is still in progress and which has been supplemented by work along the same lines at the New York State Agricultural Experiment Station. These experiments are fundamental in character and co-ordinate bacteriological, chemical, and technological phases, beginning with the cabbage, continued at intervals through the fermentation process, and in subsequent storage. The results have been published in a series of papers both of a popular and technical character. The titles are as indicated in the footnotes.

Composition of Cabbage Kraut

Round and Coppersmith, working in the Bureau of Chemistry, are quoted in The Canner, November 1, 1919, as follows, with respect to the composition of cabbage and sauerkraut:

"An average of seven American analyses indicates that the edible portion of the cabbage plant contains approximately 90 per cent water and 10 per cent solids and essentially the same proportion of water and nutri-

---

tive substance holds for sauerkraut. In each, the 10 or 11 per cent of food substance is distributed as follows:

<table>
<thead>
<tr>
<th></th>
<th>Cabbage per cent</th>
<th>Sauerkraut per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>89.8</td>
<td>88.8</td>
</tr>
<tr>
<td>Protein</td>
<td>2.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Fat</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Carbohydrates, starch, sugar, etc</td>
<td>4.4</td>
<td>2.9</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>1.5</td>
<td>5.2</td>
</tr>
<tr>
<td>Ash</td>
<td>1.5</td>
<td>5.2*</td>
</tr>
</tbody>
</table>

* 2 per cent of plant ash and 3.2 per cent salt added in curing.

"It will be seen that sauerkraut has practically the same composition as the cabbage from which it was made except the salt, which is added to it. The lactic acid (about 2 per cent) which is formed during the fermentation of the sauerkraut, replaces a portion of the carbohydrates (sugar) originally present. Other minor changes, such as the formation of a small amount of volatile acids, and a small percentage of alcohol, which also take place during the curing process, are not taken account of quantitatively in the above statement. Carbohydrate is the most abundant nutrient, while the amount of ash, though actually small, is high in comparison with very many common foods."

Peterson, Fred, and Viljoen, gave the results of their investigations upon the composition of kraut, from which the following is summarized. There were 19 analyses of cabbage:

<table>
<thead>
<tr>
<th></th>
<th>Moisture per cent</th>
<th>Sugar per cent</th>
<th>Total per cent</th>
<th>Soluble per cent</th>
<th>Calcium per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average composition</td>
<td>92.5</td>
<td>3.38</td>
<td>.20</td>
<td>.10</td>
<td>.048</td>
</tr>
<tr>
<td>Maximum found</td>
<td>93.9</td>
<td>4.20</td>
<td>.24</td>
<td>.16</td>
<td>.057</td>
</tr>
<tr>
<td>Minimum found</td>
<td>91.0</td>
<td>3.01</td>
<td>.15</td>
<td>.06</td>
<td>.034</td>
</tr>
</tbody>
</table>

Samples were drawn between August 21 and December 1, and while they seem to be quite uniform, a comparison of the maximum and minimum figures on the basis of the percentage of one to the other discloses that the sugars vary about 40 per cent, the total nitrogen about 60 per cent, and the calcium about 70 per cent.

They found the composition of kraut and kraut juice to be as follows:

**Comparison of Kraut and Kraut Juice**

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Kraut per cent</th>
<th>Kraut Juice per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>0.78</td>
<td>0.69</td>
</tr>
<tr>
<td>Titratable acid</td>
<td>1.48</td>
<td>1.67</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>0.40</td>
<td>0.45</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>1.37</td>
<td>1.45</td>
</tr>
<tr>
<td>Ethyl alcohol</td>
<td>0.48</td>
<td>0.50</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.042</td>
<td>0.043</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.027</td>
<td>0.025</td>
</tr>
</tbody>
</table>

"When sauerkraut is removed from the vat to be repacked in barrels for shipment or to be canned for the trade, a considerable quantity of kraut juice remains in the vat. While some packers can a little of this juice, most of it is discarded. This is undoubtedly wasting a product of considerable

---

1 Peterson, Fred, and Viljoen. Variations in the Chemical Composition of Cabbage and Sauerkraut. The Canner, July 18, 1925.
food value. Since the kraut juice makes up the larger part of the kraut, it should have approximately the same composition as the latter. Analyses show this assumption to be correct. The figures of the table show that the kraut juice contains approximately the same percentage of nutrients as the kraut itself, and the obvious conclusion is that it should be utilized and not discarded.

Since both cabbage and sauerkraut have been so highly regarded as a preventive of scurvy during many years, it was but natural that physiological chemists should turn to these foods as a source of vitamin C, the antiscorbutic vitamin, when that food factor became established. Fresh cabbage was found to be exceptionally rich in this substance, but a large part is destroyed in the usual process of cooking. The vitamin survives very well the fermentation process in the making of kraut. Eddy and Kohman\(^1\) reported upon the results of canning cabbage, and found much less destruction of this vitamin than in the ordinary cooking process, though their experiments omitted the usual important step of blanching, which might influence the results.

It is of some interest to note that a forerunner to these findings appeared during the third quarter of the last century to the effect that the antiscorbutic principle was “believed to depend upon a certain volatile oily principle, the chemical nature of which is imperfectly known.” Also, “in common with the rest of the cruciferous order, they (cabbage) also possess a greater show of azote than any other tribe of plants, as is apparent in their foetid smell when fermented.”

**Broccoli**

Broccoli is a long season or winter cauliflower and is handled in nearly the same manner as cauliflower.

The heads or curds are not produced as early as in cauliflower, are not nearly so well developed, are smaller and have color. Prof. E. H. Wiegand of the Oregon Agricultural College advises soaking the trimmed broccoli in a 3 per cent cold brine for as long as 24 hours then blanch in a 2\(\frac{1}{2}\) per cent brine for 3 minutes, plunge in cold water, fill and exhaust at 185° for 5 minutes and then use the same cook as for cauliflower. Since the broccoli is dark, nothing is gained from the use of citric acid in the blanch.

**Brussels Sprouts**

This variant of cabbage, having many small heads along the stem, like cauliflower and broccoli is a late development. In appearance they are wholly unlike but require very similar conditions for good growth and maturity.

Brussels sprouts heads are gathered when mature, choosing those which are about one and one-half inches in diameter and firm. The outer open leaves and all yellowish leaves are removed and the heads thoroughly washed. They are blanched until tender, which usually takes about four

minutes. Soda is recommended to be used in the blanch water at the rate of one-fourth of a pound to twelve gallons. It is said to improve the color and modify the strong flavor, making it more agreeable. The blanched heads are kept in cold water until filled into the cans. If filled hot, the heads mat together and present an unattractive appearance when the can is opened. The cans are filled with a hot salt brine, exhausted for eight minutes and cooked at 240° for 25 minutes for the No. $2\frac{1}{2}$ can, followed by immediate cooling. The cans should not be filled too full.

**Cauliflower**  
*Brassica oleracea var. botrytis.*

This variant in the cabbage family is characterized by a large overgrowth of the fleshy flowering parts and their coalescence thus making distinctive nearly solid heads varying from two to six inches across.

The plant is not so generally grown as regular cabbage as its requirements for perfect development are much more exacting. It needs a long cool season to produce heads or curds of large size, to mature evenly and of a high quality. Otherwise the development may be too rapid, the parts divided into clumps with leaves breaking in between instead of forming around the edge, and the curd becoming irregularly fibrous as well as losing its clear white color. The conditions are best met as a winter crop in Florida and around the Gulf, in California, and in small areas in other places.

The principal production is for use as a fresh vegetable and for curing in brine for pickles, though some is also canned.

The white heads or curds are broken apart, neatly trimmed, thoroughly washed, and blanched in water containing about one ounce of citric acid to the gallon. The amount of acid may be varied, made a little more or less depending upon the condition of the heads and the length of time given in the blanch. The object is to prevent the cauliflower turning a dark leaden hue which follows the cooking of the untreated heads in a tin can. The average time in the blanching is between three and four minutes, then rinsed thoroughly, filled into cans and covered with one and one-half per cent of hot brine. An exhaust of seven minutes is desirable as an aid in getting rid of some of the odor otherwise bringing the temperature up to 140° would suffice. The cook is 25 minutes at 240° for No. $2\frac{1}{2}$ cans and should be followed by prompt cooling.

Vinegar may be used in the blanch instead of citric acid though the latter is preferable. Since the acid treatment was in use long before the enactment of the pure food law, a declaration upon the label is not required.

**Canned Cabbage**

Very little cabbage is canned, as it is a vegetable that can be obtained fresh or from storage during the greater part of the year. A certain amount is packed to be used chiefly in mining camps, on board ship, and to be sent to the Far North, as Alaska.

Small firm heads are preferred for this purpose. They are stripped of all green leaves, the core removed, and the remainder divided into four
or more pieces. The pieces are blanched in hot water until soft, which usually takes from 15 to 20 minutes, or they may be laid on racks and subjected to a temperature of about 218° to 220° in a retort, in which case the time is reduced to about 5 minutes. The cabbage is filled into the cans and covered with a one and one-half per cent hot brine. A short exhaust is usually necessary to get an even warm pack before closing. It is said that if the cabbage be packed hot and brined hot that the color is a little brighter, though otherwise it appears to be somewhat water-logged. The cook usually recommended is 240° F. for 40 minutes for No. 2½ cans, and 65 minutes for No. 10 cans. Cooling needs to follow at once and be carried as low as atmospheric temperature. Cabbage tends to darken or become gray and also to form numerous minute dark particles which float in the brine, but which are minimized when the cooking and cooling are carried out promptly.

Label Weights

8Z Short, 7½ ozs.; 8Z Tall, 8 ozs.; Picnics—No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 15½ ozs.; No. 2 Special, 1 lb. 2 ozs.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 11 ozs.; No. 3, 2 lbs.; No. 5, 3 lbs. 6 ozs.; No. 10, 6 lbs. 3 ozs.

Concentrated Sauerkraut Juice

Patent No. 1,596,233, issued August 17, 1926, to Mr. C. M. Bogle, Seattle, Washington, contains the following:

As a result of research work and continued experiments, the process hereinafter to be described has been devised for the purpose of removing from sauerkraut juice the taste, for concentrating the juice, for its preservation, to increase its palatability and food value, and to treat it in a manner adapting it to a wide range of useful purposes.

Sauerkraut juice is obtained in the following manner. From the pulp portion of the sauerkraut the upper portion of the juice is drawn off and thrown away as useless. The juice for treatment is selected from the middle and lower sections of the kraut tank and should have approximately one and five-tenths (1.5) per cent acidity and salometer reading of about 40 degrees. Juice having these primary requisites may be secured only from the middle and bottom of the tank, and the juice at the top of the tank is rejected because it does not possess a sufficient acidity or salt content.

The selected juice, having been decanted from the kraut tank, is strained. After straining, the strained juice is run into an open glass-lined kettle where the strained juice is boiled until it is reduced to the required density. The boiling is continued until the concentrated juice possesses about two and five-tenths (2.5) percentum and approximately five and three-tenths (5.3) percentum of salt. Concentrated juice thus obtained and having the salt and acid content indicated possesses a bacteria count of over a billion.

When concentrated in the manner indicated and to the extent suggested, the juice has been concentrated or condensed from ten (10) parts to about three and three-tenths (3.3) parts. Such juice is of a syrupy consistence, and free from its original nasty cabbage taste.

The concentrated product in this condition is ready for bottling or otherwise preparing for shipping. In its concentrated state, it may be employed for many purposes without dilution, but in order to return the juice to the original strength possessed by it prior to concentration it is usual to add two parts of water to one part of the concentrated juice. This gives a juice of approximately the original acid and saline qualities.

From the concentrated form here described, a delightful carbonated drink may be obtained by adding thereto a low carbonation, using carbon dioxide gas, and if the carbonated product is bottled, it is suitable for fountain use.
Experiments further show that the concentrated juice is practically free from any danger of spoiling. The heat treatment the juice receives pasteurizes the product and destroys the bacteria which might cause fermentation or putrefaction. The condensed juice, either in its concentrated or undiluted form, or when diluted with a portion of water, is adapted to be consumed by drinking, the said condensed juice or the product obtained therefrom by dilution, having a pleasant saline, acid taste, and possessing a very high lactic acid ferment value. In its concentrated or syrupy state, the juice may be shipped more conveniently than when in a normal dilute condition. The product resulting from the process here described is not unlike, relatively, concentrated or condensed milk, for it may be restored to substantially normal strength but in a purified condition with water just as may be done with condensed milk. Neither sugar nor a preservative is necessary in the preservation of sauerkraut juice, and the juice obtained by the present process is the original substance, merely clarified, improved, and condensed.

**PATENT APPENDIX**

The patented and other devices used in the making of kraut and canning it are as follows:

No. 22,639, issued to J. Frazer, Rochester, New York, January 16, 1859, is for a hand cutter. It consists of a board with a slot, above which is a knife made to be adjustable for cutting slices of different thickness. The cabbage head is moved over the knife by a backward and forward motion.

No. 519,095, issued to John Rostosnik, New York, New York, May 1, 1894, is for a hand or power cutter. The blades are curved and set in a horizontal rotary disk. The heads are placed above the disk and pressed against the cutting knives by inclined boards.

No. 723,935, issued to E. R. Smith, Buffalo, New York, March 31, 1903, is for a power core cutting device. The core is cut in a spiral without being removed.

No. 898,199, issued to C. W. Hottman, Philadelphia, Pennsylvania, September 8, 1908, is for a power cutter using the principle of the rotary disk with knives, but having some distinctive mechanical features.

No. 914,262, issued to L. Lechler, Chicago, Illinois, November 23, 1909, is for a machine to split and slice the cabbage cores.

No. 920,800, issued to H. D. Wilson, Jackson, Michigan, May 4, 1909, is for a power core cutter which slits but does not remove the core.

No. 927,904, issued to A. D. Wagenhauser and H. J. Newland, Monroe, Michigan, July 13, 1909, is for a coring device having a cutter in the form of an auger to do the slitting.

No. 928,748, issued to C. B. Gedney, St. Paul, Minnesota, July 20, 1909, is for a power corer using the principle of slitting but having some new mechanical features for doing the work.

No. 969,979, issued to J. S. Randolph, Glencoe, Ohio, September 13, 1910, is for a hand power kraut cutter. The head is made to rotate and a pair of knives engage upon the surface as in an apple parer.

No. 1,002,242, issued to O. P. Ehrhardt, Seattle, Washington, September 7, 1911, is for a power core cutter, the knives being mounted on a flexible shaft so that the cutter can be thrust into the head instead of the latter being held against the machine.
No. 1,055,587, issued to H. D. Wilson, Jackson, Michigan, March 11, 1913, is for a cutter utilizing the principle of multiple blades in a revolving disk, but features some new details in the construction.

No. 1,115,697, issued to A. J. Loga, Alliance, Ohio, November 3, 1914, is for a power cutter, the cutting being done by a reciprocating action of a knife blade across the bottom of a hopper that holds the heads.

No. 1,149,954, issued to M. L. Schilly, Pierron, Illinois, August 10, 1915, is for a hand power cutter. It is essentially a small form of the regular type, but with some modifications.

No. 1,194,233, issued to A. L. Reiner, Highland, Indiana, August 8, 1916, is for a coring device. The principle of the spiral cutter is used but driven by a small individual motor, the whole so suspended that it can be directed against the heads while they are passing on a slowly moving belt.

No. 1,283,667, issued to J. Cherpech, Stafford, Canada, November 5, 1918, is for a hand operated cutter, the head being held in a fixed position and the cutting knives given a reciprocating movement.

No. 1,296,091, issued to J. S. Kriebel, East Greenville, Pennsylvania, March 4, 1919, is for a hand cutter consisting of a board with a slot and one or more double blade knives so spaced that they cut on both the forward and backward movement of the head of cabbage.

In 1923, O. H. Hansen, of Cedarburg, Wisconsin, developed a kraut filling machine intended especially to fill the cans with hot kraut, though the work can be done at any temperature. The filling is done by volume, but gives a very even weight. The recommendation is that the kraut be filled at 165° and sealed immediately without exhausting and without subsequent cooking. The experience of five years is that this is sufficient. At sixty cans per minute, the machine eliminates five hand fillers.

In 1927, a semi-automatic cabbage cutter was developed. It is known as the Bailey, Babcock, Jones machine. The distinctive feature is that the horizontal disk with its knives remains stationary and the feeding mechanism, which has four pockets, is made to revolve above the knives.

In 1927 a coring machine was invented by Whitney W. Jones, of Baltimore, Maryland. The knife is electrically driven, the distinguishing feature being that the direction of the movement of the blade is reversed to release it when the head has been pressed to the limit.

During the same year a semi-automatic coring machine was produced by Mr. Jones, which consists of a four-spindle mechanism, upon the top of each spindle being a cup-shaped receptacle to receive the heads of cabbage, core upwards. The spindles press the heads against the coring knife and discharge them on the conveyor. It reduces the hand labor in this operation about one-half.

**CARROT**

*Daucus carota.*

The carrot is a hardy garden vegetable, native of Europe and Asia, grown for its crown root or tuber. It has been known in its wild state since before the Christian Era as *Daucos* by the Greeks and *Daucus* by the Latins. Pliny refers to it as *Pastinaca gallica*. In ancient times it was not used much in cookery as the root was small and very fibrous, but it had
some reputation as a medicine. Like the beet, its improvement took place in central Europe though it was first used by the Gauls in France. The earliest record of its being grown and used fairly commonly is during the 14th century. Its long filamentous and fibrous root was changed by cultivation to different forms—long conical, nearly cylindrical with tapering end, cylindrical with blunt end, and more or less globular. At the same time the tough fibrous character gave way to a tuberous structure. There was also differentiation in color and flavor, as, the very light, sometimes called white which is sweetish but has a fibrous center; yellowish, which is tender and of a good flavor; and red, which has a strong wild flavor.

The carrot first came into popular use during the reign of Louis XV, due to the court chefs who prepared it in new and attractive ways and made it a part of many combinations of vegetables. It has played an important role in cookery ever since and is frequently called the national vegetable of France. The carrot was introduced into England from Holland during the reign of Queen Elizabeth (1558) but did not meet with popular favor as on the continent. As late as 1875, a horticultural writer said that “the market of London was principally provisioned with the carrot of Surrey, large without savor, and a heart sufficiently developed to make a cane.”

The carrot is more used in northern Europe than in any other part of the world, a condition which is generally true of root crops as the beet, sugar beet, potato, turnip, etc. There the carrot is cultivated so as to be available for the table as early as possible in the season and at the end of the season it is kept in storage well into the following spring. It is also an important food for stock.

The carrot is supposed to have been brought to this country by the early settlers, its cultivation, however, limited to a small acreage sufficient to supply the demands of a city. It is only within the present century that a large increase in its use has been developed.

Production

The carrot is grown in essentially the same way as the beet, the soil and cultural requirements being much alike, but the plant is less robust. The leaves are rather feathery and grow to a height of one and one-half to two feet. The seed is sown from early in the spring to near midsummer depending upon when the crop is wanted for canning and also whether for large or small roots. A heavy seeding is made in rows to keep the tubers of small size. The harvesting is done from shortly after midsummer to late in the fall, the yield reaching 500 bushels per acre.

Composition

The chemical composition of the carrot and beet are similar though with considerable difference in their physical characters and flavors. Dietitians generally give a higher place to the former. An analysis of the carrot as given by Wiley is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>88.59</td>
</tr>
<tr>
<td>Ash</td>
<td>1.02</td>
</tr>
<tr>
<td>Protein</td>
<td>1.14</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.27</td>
</tr>
<tr>
<td>Starch and sugar</td>
<td>7.56</td>
</tr>
<tr>
<td>Fat</td>
<td>.42</td>
</tr>
</tbody>
</table>
Since the carrot may be obtained upon the market either fresh or from cold storage during the greater part of the year, to compete those which are canned need to be of the best quality, and uniform in size, appearance, texture, and flavor. Like the beet, the packed carrot is generally of better quality and more economical than that obtained fresh which accounts for the increasing use.

**Canning**

Carrots are harvested when young and tender, the pulling and topping being the same as for beets. The size is preferably not more than one inch in diameter and two inches in length. If too small, they are inclined to be watery and without flavor; if too old, hard, sometimes woody, and with a strong flavor. Those more than one inch in diameter and up to four inches in length are better suited for soup, if tender. A deep yellow color is an asset as it presents a better appearance and is generally associated with a more pleasing taste.

The first step in their preparation is thorough washing under strong sprays followed by grading, the spaces on the grader being one inch and one and one-quarter inches, thus making three grades, those under one inch, those between one and one and a quarter inches, and those above the latter diameter.

The young carrot should be smooth with a thin skin and in this condition is easily peeled with lye if handled promptly before the outer layer of cells have become dry and corky. The apparatus used for lye-peeling peaches works well for the purpose, but the solution made stronger than for the peach. It requires from 15 to 18 pounds of lye to peel a ton of carrots using the spray method and from 25 to 30 pounds if the roots be carried through a lye bath. In the absence of a regular peeling apparatus, the lye may be heated in a large iron kettle and the carrots handled in and out in a wire basket. The time required in the lye is from one to one and one-half minutes. The operation is speeded and made more effective when the lye is near the boiling point. The lye is washed off in running water or under sprays, the latter being a patented process.

Peeling may also be done in a centrifugal machine or by hand scraping, though the latter is too expensive to be followed in this country. A medium size centrifugal machine will handle from 800 to 1,000 pounds per hour. Hand trimming is a necessity to remove the greenish crown and any spots which may have escaped by either of the other methods.

The French advocate a thorough blanching of the carrot, 5 to 6 minutes for the small roots and 10 to 12 minutes for the large ones, followed by immediate chilling. The cans are filled and a brine composed of 1½ per cent salt and 4 per cent sugar is used instead of a plain salt brine.

The cans are exhausted to produce a temperature of from 140° to 150° F. followed by a cook at 240° F. for 25 minutes for No. 2½ cans and 45 minutes for the No. 10 can. Plain cans are used.

The French also prepare whole carrots with butter, and with meat stock instead of brine. In the regular preparation of carrots for the table since the 16th century butter has been used so that it is natural to use it in the canned. The carrots are packed closely together in the can in order that the amount of melted butter required to cover be reduced to the minimum.
The same applies also to the use of condensed meat stock. In other respects the packing and cooking are the same as with brine.

For soup large carrots are packed whole and sliced, diced, or cut into fancy shapes, screened to get rid of the small irregular bits, cooked in a kettle for ten minutes, then filled into cans hot, and cooked at 240° F. for 50 minutes for the No. 10 size.

This product is used almost exclusively by hotels, restaurants, and commercial soup manufacturers.

**Label Weights**

The weights recommended for declaration upon the label are as follows:

- 8Z Short, 7½ ozs.; 8Z Tall, 8¾ ozs.; Picnic, No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1½ lb.; No. 2 Special, 1½ lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; and No. 10, 6 lbs. 8 ozs.

**Vacuum Pack**

No. 2 Squat, 10 ozs.; and No. 3 Squat, 1 lb. 2 ozs.

---

**CELERY**

*Apium graveolens.* L.

Celery is a modern garden vegetable. In its wild state it is better known as *Ache,* one of the most widely distributed plants, native to nearly the whole of Europe from Sweden to the Mediterranean, from the west coast to the Caucasus, from Beloochistan to India, to Egypt and Abyssinia in Africa, and with related species on the west coast in this country and in New Zealand. In the uncultivated state it grows around ponds, in marshes, and ditches and presents a very different appearance from the cultivated plant. Wild celery has a disagreeable strong taste and odor and is mildly poisonous. In ancient times it was used as a medicine and as a funeral plant, that is, in decoration for the dead by the Romans, Greeks, and Egyptians. Pliny is the only one of the early writers who makes a distinction between the wild *Ache* and a cultivated variety in which the leaves are blanched with a consequent reduced bitterness. It is known that there is a good deal of difference in the bitterness of strains of the wild type so that some may have been edible, but this is the first, though indirect, intimation that they may have been so used. This wild type came into renewed notice during the 12th to the 15th centuries as a cultivated medicinal plant but not as a potherb. Its first use for this latter purpose was in Italy where it had been modified to a certain extent to produce larger and heavier petioles. The term celery was introduced at the same time as the new type. The Italians were noted for their use of highly aromatic and flavored vegetable dishes and this harmonized with their style of cookery, though in other countries the plant was not popular so that its usage extended very slowly. Parkinson, an early English herbalist (1629) states that "Sellery" is a rarity. At this same period and later the French works upon cookery give scant mention to it.

The different ways for treating celery to make it more tender through etiolation, by banking with earth or straw, have been known since 1690
and the gardener for Louis XIV grew the celery in trenches so that the soil might be drawn toward it to get the same effect as others obtained by ridging. There was only one variety known at that time.

The earlier varieties of celery retained some of their wild habit in their prolific suckering which reduced growth in the main plant. The gardeners finally overcame this by selection. In 1875, a Frenchman went a step farther and developed a race with naturally blanched stems. The improvements since then have been in the size of the plants and elimination of wild flavor by the development of a characteristic and pleasing one.

Celery is not grown generally in gardens but is handled on a rather large scale as a specialty in certain places, principally in New York, Michigan, California, Utah, and Florida. It needs a rich loose bog land which is well drained but with a water level within a few feet of the surface, and requires much hand labor in its cultivation though by using the self-blanching strains and planting close together so that the foliage touches, banking is unnecessary and the final work of harvesting is reduced. Banking is always attended by the drawbacks of a certain amount of heart rotting, insect attack, and dirt between the stems. The flavor of self-blanching celery is not considered equal to that obtained by horticultural methods, but is improved by cold storage of from fifteen to thirty days or more and this is likewise true for the texture if it be stringy.

Celery is a most important salad plant and for that purpose it is held in cold storage and with entire success. It is also much used as an ingredient in soups.

Canning

Preservation of celery by canning has been carried on by the French for more than sixty years but only in a small way. In addition to plain packing, they also prepare it with dressings of concentrated beef broth and butter. In this country its canning goes back only about thirty years and has likewise been a small pack, principally to be used in soups. S. J. Dunkley at Kalamazoo, Michigan, was the first to place it on the market.

The canning of celery is essentially a hand operation requiring only the simplest equipment. The branches are either broken apart or the stems are cut off close to the crown, the leafy portion discarded or chopped for use in soups or purées, and the stems thoroughly washed under sprays with a high water pressure. There is always some sand and soil present and so closely adherent between the stems that it cannot be removed without brushing or sharp sprays, the latter being the more economical for the purpose. The stems are then cut to within three-eighths of an inch of the height of the can if they are to be packed in asparagus style. The parts which remain or the whole stem may be cut into short lengths, as one-eighth, one-quarter, three-eighths, or one-half inches for soup. The regular vegetable slicers are generally employed for this purpose.

Celery intended for salad may be blanched either in a half per cent salt solution or in a two per cent citric acid solution, the time in the former being about four or five minutes and in the latter about three to four minutes. The blanching in citric acid produces a much whiter and crisper product and since practically all the acid taste is removed by washing, it is not only suitable for salads but also for other purposes. Celery becomes rather dull gray and lifeless after canning unless treated as indicated. The
celery has also been treated by soaking over night in a weak vinegar solution. Madam Raymond, one of the most careful of the French writers on canning, prefers that celery be blanched for five minutes in very weak brine and that only plain water be used in the cans as it is injured by salt. The cans are filled and hot water added.

The cut stems and also the sliced hearts intended for soup stock are cooked in a kettle for five minutes to soften the tissue so that the can may be well filled. The clean sound leaves may be cooked for a half-hour or more and the water extract used for filling the cans as it contributes to the flavor. To fill the can without precooking necessitates a long exhaust with a consequent appearance of slack filling. The hearts may be trimmed, blanched, and packed as a separate product or they may be sliced to be used in soup. Some celery has been prepared by running it through a grater to be used in purée or in cream of celery soup but it is generally considered more satisfactory to can it as soup stock and run it through a screen just before its final preparation.

The cook used on celery has probably never been determined experimentally but follows that learned by experience as correct for other vegetables. For No. 2 cans and smaller, the temperature recommended is 240° F. for 25 minutes and for No. 10 cans, 45 minutes. The French use 230° F. for 20 minutes for the half liter (not quite a No. 2 size). The Germans use 240° F. for 10 minutes for the No. 2, 15 minutes for the No. 3, and 20 minutes for the No. 5.

The cook recommended by the California State Board of Health for celery hearts in No. 2 1/2 cans or smaller is 240° for 20 minutes; celery cuts, 25 minutes; and cuts in No. 10 cans, 35 minutes.

Since the packing is largely for public eating places, the cans chosen are most often No. 2 or No. 10.

A style of packing also known as celery hearts is done in Utah. It consists of the crown trimmed short and the inner clumps of stems left attached but cut to a length corresponding to the height of a No. 2 can. Some are also packed in extra tall or 7 inch No. 2 cans. This style of packing was begun in 1925 and has developed to 25,000 cases in five years.

Celeriac

Apium graveolens var. rapaceum.

Celeriac, celery root, or turnip rooted celery, is an older domestication of the wild Ache than is celery and as with the latter it seems to have had its origin in Italy. It is mentioned in De natura stirpium, 1536, as being eaten either raw or cooked. The plant bears a very close resemblance to celery but differs in that the crown is well developed instead of the leaf stems, the latter remaining practically the same as when in the wild state. The root crown attains a size of from 2 to 4 inches in diameter, nearly globular in shape with many small side branches. The greater part of it develops below the surface of the soil. Growth takes place under practically the same gardening conditions as for celery.

The plant is little known in this country except among the people who have come from southern Europe. The culture, however, is increasing.
It has a decidedly stronger flavor than stalk celery and is used chiefly as an ingredient of soups.

The root is harvested late in the fall, washed, and peeled by hand. It is diced by machines, blanched four minutes, filled into the can, brine added, and cooked 30 minutes at 240° F. The packing is done in the No. 1 can as that amount usually suffices to mix with other vegetables in the making of soup or in mixtures accompanying meats to impart flavor.

**CORN**

*Zea mays*

Corn is distinctively an American product, as all available evidence is to the effect that the plant is native to this continent, probably Mexico, and unknown to Europe until carried there by Columbus, or to other places except as introduced by travelers. The term *Maize* was given to it by Columbus from the Spanish *Maíz*, derived from *Mahiz*, used by the Haytians. Corn was one of the few plants cultivated by Indians in Mexico, Peru, and the southern part of this country, and later evidence shows that the cultivation had been carried on for a very long time. It was taken up at once by the new settlers and soon became the most important grain for the preparation of various foods for the table and as a source of both grain and fodder for animals. One variety, sweet corn, is peculiarly suited to be eaten in the immature stage or prepared in that stage for consumption later. The Indian usage of corn is recalled by their words for some of the present preparations, as hominy, samp, and succotash. The canning of corn is likewise an American development in the art of preservation.

**Botanical Position of Corn**

Botanically corn occupies a peculiar position. It belongs to the large order Graminaceae or grasses, to the single genus *Zea*, of which it is the only member and which contains only a single species, *Mays*. This species is very variable, first dividing into two lines, the flint and the dent, and these subdividing by the number of rows of grains, their size, shape, etc. Instead of designating its subdivisions as varieties, they are dignified as "agricultural species," and thus sweet corn becomes *Zea mays*, var. saccharata. The weakness of the classification is shown by the fact that Golden Bantam sweet corn is from the flint strain while Stowell's Evergreen is from the dent strain.

Corn is a tender annual having the appearance of a large coarse grass which grows to a height of from four to ten feet. The main stem is from one-half to an inch or more in diameter, but not strongly fibrous. The long opposite leaves are thin. The male flowers are borne on a tassel at the top and the female on the silks on short stems from the axils of the leaves about midway on the main stalk. These latter number from 1 to 3 or even more. The seeds or grains are closely attached to a cylindrical thickened base, the cob, and are covered with several layers of husks or leaves developed for that purpose. The grains are generally in rows of eight or more, and vary from a broad flat type to those narrow and long. The ripe seeds of the sweet corn are distinctive in that they are more or less horny and wrinkled with a semi-translucent appearance, especially
near the edge. Another feature is that while in the immature state the kernels are sweet with a distinctive flavor, due to the high sugar content.

Sturtevant,* who prepared a monograph on sweet corn in 1899, states that our knowledge of sweet corn dates to 1779, when it was first introduced into Massachusetts near Plymouth. The seed was obtained from the Susquehanna Indians and given the name Papoose corn. It was an eight-rowed variety on a red cob. Mammoth Sweet and Stowell’s Evergreen are listed in 1853; Schenck, in 1854, states that there were two varieties; Klippart, in 1858 records six varieties; Burr, in 1866, 12 varieties; Sturtevant, in 1884, describes 33 varieties, and this he increased to 61 in a later monograph.

Prof. A. T. Erwin of the Iowa State College has given a great deal of study to the origin of sweet corn and has supplied the following data upon the canning varieties.

"In the earlier stages of development of both field and sweet corn the sugar content is relatively high. In the case of field corn the sugar is converted into starch as the ear reaches maturity. The starch grains fill out the endosperm, making the kernels plump. In the instance of sweet corn, however, such is not the case. With sweet corn the conversion of sugar to starch goes on very slowly and is incomplete at the time the stalks die. The starch grains which have formed are small and only partially developed and do not fill the endosperm; consequently as the water dries out the sweet corn kernel shrinks severely, causing the wrinkled appearance characteristic of sugar corn. Sweet corn has therefore been characterized as field corn which has lost its ability to form starch normally.

Origin of Sweet Corn

"Sweet corn was formerly regarded as a distinct species but recently genetic studies indicate that it is merely a botanical variety of field corn. In other words, it is field corn in an arrested stage of development as regards the conversion of sugar to starch and probably developed after the white man came to our shores. There are two important types of field corn—the dents and the flints, from both of which probably have been derived varieties of sweet corn. The Bantam and Crosby belong to the flint type, while the Stowell’s Evergreen and numerous other varieties belong to the dented type of field corn.

"The four leading canning varieties are Crosby, Country Gentleman, Stowell’s Evergreen, and Golden Bantam.

Crosby

"This variety was developed about 1860 by Josiah Crosby of Arlington, Massachusetts. Mr. Crosby was much interested in plant breeding as an avocation and truck farming as a vocation. He is also credited with the development of the Crosby beet, which is still a leading commercial variety.

"His variety of sweet corn was listed as Crosby’s Extra Early Sugar Corn in 1872 in Ferry and Company’s catalogue. It is a late season variety and reaches its canning stage in the corn belt in approximately 85 to 90 days, is still a leading commercial sort and is a favorite variety of the packers in Maine and Minnesota. The ears commonly range from 14 to 16 rows, although there is an early 12-rowed strain.

Country Gentleman

"The early history of this type of corn appears never to have been cleared up. According to Fred Clark of Milford, Connecticut, the first zigzag type of sweet corn grown in the United States was known as the Shoe Peg, and G. H. Rieman of the Associated Seed Growers states that there is a local tradition among the growers of Orange, Connecticut, that the Shoe Peg originated in that locality.

"The variety of corn of this type which followed the Shoe Peg was the Ne Plus Ultra. This variety was extensively grown by canners around Aberdeen, Maryland, about 1875. Ne Plus Ultra was listed by Ferry and Company in 1885. Whether it was offered in the seed trade at an earlier date than this or not is not known.

"Country Gentleman was introduced by Peter Henderson and Company as a selection from Ne Plus Ultra. According to Wilkinson* this variety is a cross between Ne Plus Ultra and Stowell’s Evergreen. From a genetic standpoint we find no basis for this statement.

"Country Gentleman has maintained its place as the highest quality canning variety for four decades. It is grown extensively throughout the corn packing regions of the United States and has played a leading role among the packers of the better grades of corn. The ears are characterized by irregular rows of narrow, deep grains, the cob comparatively small and about 8 inches in length.

Stowell’s Evergreen

"This variety was developed by a truck gardener named Nathan Stowell, who resided near Burlington, N. J. It was introduced by Thorburn and Company in 1861. It had evidently come to the notice of the public some years previous to this date as the United States Patent Office, which at that time embraced the United States Department of Agriculture, in their report for 1853 refer to the “late green keeping Stowell Sweet under the name of Stowell’s Late Green.” The name Late Green appears to have been altered to Evergreen in the interest of brevity at the time of its introduction. Stowell’s Evergreen is one of the oldest varieties still in cultivation; in fact it probably represents the largest commercial acreage of sweet corn of any one variety grown in America, and it constitutes the leading commercial sort for the standard grade of corn. The ears are from 8 to 10 inches long, 2 3/4 to 2 1/2 inches in diameter with from 16 to 20 rows of medium to wide white kernels.

Golden Bantam

"Golden Bantam was originated by J. G. Pickett of Greenfield, Massachusetts, and was introduced in 1902 as Burpee’s Golden Bantam by W. Atlee Burpee and Company. David Burpee states that the introducers had difficulty at first in popularizing the variety, as it was the first important yellow sweet corn to be introduced and there was considerable sales resistance because of its being yellow as it was thought it might be field corn. The reputation of Golden Bantam as the corn par excellence for quality has increased through the years and it is today the yardstick by which all other varieties are measured for quality. Numerous crosses have been

made between the Bantam and other large eared varieties, some of which have merit from the standpoint of better yield than Bantam and rank well as to quality though with many of them the delicate flavor and tender pericarp are lacking.

"The ears of Golden Bantam range from 5 to 6 inches in length, 8 rowed, and rather broad shallow kernels. The stalks range from 5 to 5½ feet in height and often bear two years. On account of its light tonnage per acre it is rather expensive corn as a canned product and will probably be supplanted by Bantam crosses. For the home garden it is still the favorite.

"Yellow corn was known previous to the introduction of Golden Bantam but made little headway. In the United States Patent Office report for 1853 reference is made to a variety called the Yellow Shoe Peg, and Livingston listed a variety in 1890 called Gold Coin."

Much stress has been placed upon the importance which the Indian attached to corn as a food and the promptitude with which the European immigrant adopted it as a staple. This is true for the mature grain but the evidence of general use of the green ear as a table vegetable is rather meager. Unfortunately there was only one purely American cookbook published before 1800 and that makes no mention of green corn. There is only a bare mention of boiled green corn in "The Frugal Housewife," an American reprint of an English work, in 1829, and the first mention of sweet corn in "The American Housewife" in 1839. There were a number of cookbooks published around 1850 in which sweet corn is given its proper place.

One book in particular deserves mention, "The Practical Cook Book," by Mrs. Sylvia Cambell, published in Cincinnati, Ohio, in 1855. In addition to telling how to prepare green sweet corn, succotash, and hominy, it gives the following method "To Preserve Peas, Beans and Sweet Corn."

"Let them be well boiled, and while scalding hot put them in tin cans, with an aperture in the top cover. Let the can stand in hot water while the opening is being soldered on, which will serve to expel the air more perfectly. Separate the sweet corn from the cob and boil the latter first, to get out all the sweetness, and then boil the corn in the same water. When opened for use these articles will only need scalding and seasoning to the taste to render them as fresh and desirable in winter as at the time they were first prepared."

In another paragraph it is stated, "Vegetables should be partially cooked first. Such as corn, peas, and tomatoes should be boiled a half hour; asparagus, a quarter hour.

"To the vegetables, add a half pint of the water they are cooked in, to the quart.

"The article requires boiling twice while in the cans. After securing down the cap with the fingers, put the cans in boiling water, and boil the length of time below mentioned. Then unscrew the caps, leaving them off two minutes, when the cap should again be secured on, and fastened tightly with the wrench made for the purpose, and boil again as below.

"On removing from the water the second time, and while hot, fill up the little bowl or sealing chamber with melted beeswax. It is the beeswax in the chamber, in combination with the rubber compress, that prevents access of air to the contents.
“Green peas, corn, or beans, first boiling, 3 hours; second boiling, 3 hours.”

Statistics Concerning the Canning Crop

The acreage, yield, production, price paid per ton, and value in the several states for 1934 was reported by the United States Department of Agriculture to be as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>Acreage</th>
<th>Yield per acre, tons</th>
<th>Production, tons</th>
<th>Price paid per ton</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>10,900</td>
<td>3.6</td>
<td>39,200</td>
<td>$14.90</td>
<td>$584,000</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>700</td>
<td>3.2</td>
<td>2,200</td>
<td>14.50</td>
<td>32,000</td>
</tr>
<tr>
<td>Vermont</td>
<td>1,050</td>
<td>2.7</td>
<td>2,800</td>
<td>10.80</td>
<td>30,000</td>
</tr>
<tr>
<td>New York</td>
<td>14,600</td>
<td>2.3</td>
<td>33,600</td>
<td>11.00</td>
<td>370,000</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>5,400</td>
<td>1.7</td>
<td>9,200</td>
<td>10.00</td>
<td>92,000</td>
</tr>
<tr>
<td>Ohio</td>
<td>21,000</td>
<td>1.9</td>
<td>39,900</td>
<td>7.20</td>
<td>287,000</td>
</tr>
<tr>
<td>Indiana</td>
<td>38,500</td>
<td>1.3</td>
<td>50,000</td>
<td>8.30</td>
<td>415,000</td>
</tr>
<tr>
<td>Illinois</td>
<td>63,000</td>
<td>1.4</td>
<td>89,200</td>
<td>7.60</td>
<td>669,000</td>
</tr>
<tr>
<td>Michigan</td>
<td>5,000</td>
<td>0.9</td>
<td>4,500</td>
<td>9.70</td>
<td>44,000</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>11,900</td>
<td>2.3</td>
<td>27,400</td>
<td>8.00</td>
<td>219,000</td>
</tr>
<tr>
<td>Minnesota</td>
<td>47,800</td>
<td>1.7</td>
<td>81,300</td>
<td>6.00</td>
<td>488,000</td>
</tr>
<tr>
<td>Iowa</td>
<td>27,000</td>
<td>1.9</td>
<td>51,300</td>
<td>6.20</td>
<td>318,000</td>
</tr>
<tr>
<td>Nebraska</td>
<td>1,000</td>
<td>1.2</td>
<td>1,200</td>
<td>6.00</td>
<td>7,000</td>
</tr>
<tr>
<td>Delaware</td>
<td>2,400</td>
<td>2.5</td>
<td>6,000</td>
<td>9.50</td>
<td>57,000</td>
</tr>
<tr>
<td>Maryland</td>
<td>29,100</td>
<td>1.5</td>
<td>43,600</td>
<td>10.00</td>
<td>436,000</td>
</tr>
<tr>
<td>Tennessee</td>
<td>2,130</td>
<td>2.5</td>
<td>5,300</td>
<td>8.70</td>
<td>46,000</td>
</tr>
<tr>
<td>Other States</td>
<td>4,540</td>
<td>2.0</td>
<td>8,900</td>
<td>9.89</td>
<td>88,000</td>
</tr>
<tr>
<td>Total</td>
<td>286,720</td>
<td>1.7</td>
<td>495,600</td>
<td>8.44</td>
<td>4,182,000</td>
</tr>
<tr>
<td>1930 Total</td>
<td>350,560</td>
<td>1.8</td>
<td>658,900</td>
<td>14.65</td>
<td>8,744,000</td>
</tr>
</tbody>
</table>

Distribution of the Industry

Although corn is by nature a heat-loving plant, early maturing varietites have been developed so that it can be grown in practically all the states and in southern Canada. At least, it can be grown so that the ear will be in the green stage before frost, though it may not ripen. It is best grown for packing purposes in the cooler sections, or planted so late in the summer that the ears develop during cool weather. This is due to the fact that changes in the kernel take place so rapidly during hot weather that only a part of the ears can be harvested while in prime condition, whereas the changes occur much more slowly during a cool period so that a higher percentage of a prime product may be secured. It is because of climatic conditions favoring slow maturity that Maine corn acquired a high reputation for quality at an early date and has maintained it, and not due to any peculiarity of the corn itself. The principal packing is therefore done in the north and east sections of the country, from Maryland north to Maine, west to Nebraska, and north to Minnesota. Very little packing is done outside this area, but some shifting in production is taking place within the territory, particularly in the increased area devoted to corn in Wisconsin and Minnesota and a contraction of the acreage farther south.

Between 1905 and 1908, the Bureau of Chemistry caused an investigation* to be made relative to the quality of sweet corn grown along the east coast from South Carolina to Maine. Only slight chemical differences were found in the corn from the different sections. The conclusion formulated by Dr. Wiley was as follows: "The chief difference between

the Indian corn of the extreme North and that of the extreme South is
found not so much in its content of sugar as in its succulence, the lower
temperature of the North making the corn more tender and edible for a
longer period than the extremely high temperatures of the South. The
season, therefore, during which the green Indian corn can be used and kept
in good condition is longer in the North than it is in the South; in other
words, the ripening process is not so rapidly completed in the North."

Early Attempts at Canning

While canning of corn is not an old process, its early history is hazy due
doubtless to the number of failures and these are not usually divulged. The
credit for its accomplishment is usually given to Isaac Winslow probably
because of the persistence displayed in staying with the problem and the
publicity attending litigation over certain patents.

According to F. O. Conant,* Winslow was from Philadelphia but en-
gaged in the whaling business out of Portland, Maine. In one of his trips
to France he learned of the canning of foods and their great advantage
in shipstores, especially in keeping sailors in better health. This appealed
to him most strongly and in 1839 he tried packing some corn. His first
attempt was with corn on the cob but this provided too little corn in a can
considering the high cost of the containers and moreover nearly all the
cans spoiled. He next tried removing the grains with a two-tined fork, the
tines passing between the rows and the grains pushed off. This was too
slow and laborious and again spoilage claimed nearly the entire pack. This
experience led to cutting the corn from the cob by means of a butcher knife
and then with one provided with a guard to regulate the depth. In 1842,
he had a small patch of corn grown especially for canning which fixes the
date of the first crop produced for the purpose. In these experiments, the
cooking was done in an ordinary wash boiler, using four hours at boiling
temperature. In 1843, he had a copper boiler constructed which would
hold about one barrel of water and in which he could develop ten to fifteen
pounds steam pressure. He built a heavy plank box, lined it with zinc and
turned the steam into the box to do the cooking. This marks an attempt
to produce a retort but must have been so poorly constructed that the re-
results were less favorable than the open water bath and therefore aban-
donned as wrong in principle.

In 1844, Winslow transferred his work to Philadelphia and tried year
after year to achieve success. Each time there was a sufficient number of
cans that would keep to encourage another trial but it was not until 1858
that he felt sufficient confidence in his results to apply for a patent. That
instrument was not granted until 1862, some time after his death.

In a suit filed for infringement upon this patent, it developed that
Thomas B. Smith, of Philadelphia, had a copy of Appert’s book, and that
he had tried to can corn in 1837 and succeeding years. Smith and Winslow
were good friends, and it is believed that each knew what the other was
doing. It also developed that Edward Wright, Daniel Holt, and Caleb S.
Malthy, of Baltimore, had paid considerable sums to Thomas Kensett for
instructions in canning, and that Wright began canning corn in 1841 and
continued until his death in 1852, but no record of the experiences of these
packers has been made public.

*Deming, O. L. Science and Experiment as Applied to Canning. Chicago, 1902.
Winslow tried particularly to conserve all of the edible portion of the grain, adding the pulp or scraping to the cut portion thereby creating a type of product known as cream or Maine style. This made sterilization much more difficult and doubtless contributed to his failures. Whole grain in brine, or Maryland style, did not arrive until years later, nor did it become an important item in packing until within the past decade.

Nathan Winslow, a brother of Isaac, and John Winslow Jones, a nephew, continued canning at Portland, and there is a record of a sale of one dozen cans of corn to Samuel S. Pierce, of Boston, February 19, 1848, for the sum of $4.00.

The firm of Treat, Noble & Co., of Eastport, Maine, was formed in 1839 for the packing of fish and lobsters, and some time before 1853 they packed some corn. Rumery and Burnham packed corn in Portland in 1853 or 1854, and about this time Kemp, Day & Co. tried packing on a large scale with the loss of about 100,000 cans, worth at that time $3.50 a dozen.

In 1867, John Winslow Jones, to whom the Winslow patents had been assigned, began suit against R. K. Sewall for an infringement, which was won in the lower court and reversed in the higher in 1875. The next year and amended suit was begun against Louis McMurray & Co. of Baltimore, and was compromised. The defense in each case had the united support of nearly all interested canners, and was the most bitterly fought of all patent suits up to the Dunkley lye-peeling litigation.

With this controversy ended, the development of a machine cutter, pre-cooking before filling into cans, and the introduction of the retort for processing, the way was opened for improvement in the methods and a large expansion of the business. No other line has been more productive of mechanical devices to accomplish so many complex operations and yet in such simple manner that the work can be carried on with almost equal facility on a small or large scale. Hand labor has been almost eliminated, being reduced to such operations as require judgment. The extremes are well illustrated in that in Maine some of the smaller factories use the product from less than a hundred acres and the growing is done in patches of from two to ten acres, while one factory in Illinois utilizes the crop from four thousand acres and single fields cover more than a half section.

The growth of the industry was rapid following the invention of special machines for handling the product and reached nearly 7,000,000 cases by 1900. Since then the increase has been slower and irregular. The total is large when one considers that the consumption is local, there being practically none exported. Prior to 1880, nearly all the canning was done on the east coast of Maine, New York, and Maryland, and was just beginning to get a hold in the central states. The first commercial canning of corn west of the Alleghenies was by Thomas Duckwall at Mount Washington, Ohio, in 1866, and two years later at Elgin, Illinois. In 1879, packing was started at Hoopeston, Illinois, on what was then considered a large scale, using the product of one hundred and twenty-five acres. The census of 1890 shows how rapidly the change was made to get into the "corn belt" with the hope of getting larger yields at less cost. Since 1920 the shift has been made farther north to take advantage of the cooler climate during the period of maturation.
Statistics Concerning Recent Packing

PACKS OF CORN IN THE UNITED STATES*

<table>
<thead>
<tr>
<th>State</th>
<th>1912</th>
<th>1913</th>
<th>1914</th>
<th>1915</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>2,438,000</td>
<td>1,339,000</td>
<td>1,515,000</td>
<td>2,081,000</td>
</tr>
<tr>
<td>Indiana</td>
<td>1,235,000</td>
<td>785,000</td>
<td>694,000</td>
<td>785,000</td>
</tr>
<tr>
<td>Iowa</td>
<td>2,961,000</td>
<td>884,000</td>
<td>1,573,000</td>
<td>1,223,000</td>
</tr>
<tr>
<td>Maine</td>
<td>801,000</td>
<td>650,000</td>
<td>1,114,000</td>
<td>942,000</td>
</tr>
<tr>
<td>Maryland</td>
<td>1,517,000</td>
<td>1,023,000</td>
<td>1,364,000</td>
<td>1,609,000</td>
</tr>
<tr>
<td>Minnesota</td>
<td>321,000</td>
<td>188,000</td>
<td>224,000</td>
<td>121,000</td>
</tr>
<tr>
<td>New York</td>
<td>1,009,000</td>
<td>393,000</td>
<td>771,000</td>
<td>1,016,000</td>
</tr>
<tr>
<td>Ohio</td>
<td>1,376,000</td>
<td>984,000</td>
<td>1,203,000</td>
<td>1,144,000</td>
</tr>
<tr>
<td>Delaware</td>
<td>658,000</td>
<td>466,000</td>
<td>730,000</td>
<td>722,000</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>519,000</td>
<td>377,000</td>
<td>342,000</td>
<td>208,000</td>
</tr>
<tr>
<td>Other States</td>
<td>274,000</td>
<td>203,000</td>
<td>259,000</td>
<td>273,000</td>
</tr>
<tr>
<td>Total</td>
<td>13,109,000</td>
<td>7,283,000</td>
<td>9,789,000</td>
<td>10,124,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>1916</th>
<th>1917</th>
<th>1918</th>
<th>1919</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>1,540,000</td>
<td>2,421,000</td>
<td>2,199,344</td>
<td>2,225,000</td>
</tr>
<tr>
<td>Indiana</td>
<td>797,000</td>
<td>742,491</td>
<td>512,688</td>
<td>586,000</td>
</tr>
<tr>
<td>Iowa</td>
<td>1,730,000</td>
<td>2,280,366</td>
<td>2,300,241</td>
<td>2,496,000</td>
</tr>
<tr>
<td>Maine</td>
<td>782,000</td>
<td>566,498</td>
<td>1,112,912</td>
<td>1,652,000</td>
</tr>
<tr>
<td>Maryland</td>
<td>1,448,000</td>
<td>2,001,544</td>
<td>2,032,944</td>
<td>2,081,000</td>
</tr>
<tr>
<td>Minnesota</td>
<td>278,000</td>
<td>201,969</td>
<td>309,136</td>
<td>456,000</td>
</tr>
<tr>
<td>New York</td>
<td>280,000</td>
<td>257,296</td>
<td>488,912</td>
<td>1,014,000</td>
</tr>
<tr>
<td>Ohio</td>
<td>930,000</td>
<td>1,200,131</td>
<td>1,584,064</td>
<td>1,360,000</td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>725,000</td>
<td>659,087</td>
<td>389,295</td>
<td>777,000</td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>322,000</td>
<td>165,492</td>
<td>372,924</td>
<td>635,000</td>
</tr>
<tr>
<td>Other States</td>
<td>298,000</td>
<td>306,188</td>
<td>419,400</td>
<td>268,000</td>
</tr>
<tr>
<td>Total</td>
<td>9,130,000</td>
<td>10,803,015</td>
<td>11,721,860</td>
<td>13,550,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>1920</th>
<th>1921</th>
<th>1922</th>
<th>1923</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>2,271,000</td>
<td>1,711,000</td>
<td>1,939,000</td>
<td>2,833,000</td>
</tr>
<tr>
<td>Indiana</td>
<td>861,000</td>
<td>709,000</td>
<td>665,000</td>
<td>2,208,000</td>
</tr>
<tr>
<td>Iowa</td>
<td>3,246,000</td>
<td>1,190,000</td>
<td>1,959,000</td>
<td>2,382,000</td>
</tr>
<tr>
<td>Maine</td>
<td>1,588,000</td>
<td>911,000</td>
<td>1,066,000</td>
<td>923,000</td>
</tr>
<tr>
<td>Maryland</td>
<td>2,217,000</td>
<td>1,130,000</td>
<td>1,944,000</td>
<td>2,256,000</td>
</tr>
<tr>
<td>Minnesota</td>
<td>643,000</td>
<td>573,000</td>
<td>598,000</td>
<td>898,000</td>
</tr>
<tr>
<td>New York</td>
<td>829,000</td>
<td>564,000</td>
<td>616,000</td>
<td>434,000</td>
</tr>
<tr>
<td>Ohio</td>
<td>1,544,000</td>
<td>850,000</td>
<td>1,073,000</td>
<td>1,390,000</td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>764,000</td>
<td>440,000</td>
<td>701,000</td>
<td>842,000</td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>590,000</td>
<td>576,000</td>
<td>635,000</td>
<td>648,000</td>
</tr>
<tr>
<td>Other States</td>
<td>487,600</td>
<td>189,000</td>
<td>233,000</td>
<td>292,000</td>
</tr>
<tr>
<td>Total</td>
<td>15,040,000</td>
<td>8,843,000</td>
<td>11,419,000</td>
<td>14,106,000</td>
</tr>
</tbody>
</table>

*Almanac of the Canning Industry. 1935.
Statistics Concerning Recent Packing

PACKS OF CORN IN THE UNITED STATES

<table>
<thead>
<tr>
<th>State</th>
<th>1924</th>
<th>1925</th>
<th>1926</th>
<th>1927</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>2,310,000</td>
<td>4,030,000</td>
<td>3,361,000</td>
<td>1,961,000</td>
</tr>
<tr>
<td>Indiana</td>
<td>846,000</td>
<td>2,223,000</td>
<td>2,044,000</td>
<td>703,000</td>
</tr>
<tr>
<td>Iowa</td>
<td>1,764,000</td>
<td>4,105,000</td>
<td>3,953,000</td>
<td>1,376,000</td>
</tr>
<tr>
<td>Maine</td>
<td>1,294,000</td>
<td>1,693,000</td>
<td>1,347,000</td>
<td>805,900</td>
</tr>
<tr>
<td>Maryland</td>
<td>1,707,000</td>
<td>3,678,000</td>
<td>2,133,000</td>
<td>1,493,000</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1,199,000</td>
<td>1,541,000</td>
<td>1,762,000</td>
<td>1,088,000</td>
</tr>
<tr>
<td>New York</td>
<td>749,000</td>
<td>1,311,000</td>
<td>1,038,000</td>
<td>675,000</td>
</tr>
<tr>
<td>Ohio</td>
<td>787,000</td>
<td>2,375,000</td>
<td>1,735,000</td>
<td>845,000</td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td>680,000</td>
<td>1,484,000</td>
<td>953,000</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
<td></td>
<td></td>
<td>598,000</td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
<td>388,000</td>
<td>1,148,000</td>
<td>843,000</td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
<td>407,000</td>
<td>732,000</td>
<td>226,000</td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
<td>666,000</td>
<td>782,000</td>
<td>1,080,378</td>
</tr>
<tr>
<td>Other States</td>
<td></td>
<td>1,137,000</td>
<td>1,550,000</td>
<td>1,870,833</td>
</tr>
<tr>
<td>Total</td>
<td>12,131,000</td>
<td>24,320,000</td>
<td>19,069,000</td>
<td>10,346,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>1928</th>
<th>1929</th>
<th>1930</th>
<th>1931</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>3,016,000</td>
<td>3,152,000</td>
<td>3,261,074</td>
<td>3,788,167</td>
</tr>
<tr>
<td>Indiana</td>
<td>1,131,000</td>
<td>1,250,000</td>
<td>1,272,291</td>
<td>2,362,179</td>
</tr>
<tr>
<td>Iowa</td>
<td>2,541,000</td>
<td>2,908,000</td>
<td>2,552,023</td>
<td>3,227,229</td>
</tr>
<tr>
<td>Maine</td>
<td>966,000</td>
<td>1,521,000</td>
<td>1,929,864</td>
<td>1,245,375</td>
</tr>
<tr>
<td>Maryland</td>
<td>1,648,000</td>
<td>1,865,000</td>
<td>621,961</td>
<td>1,955,761</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1,647,000</td>
<td>2,604,000</td>
<td>2,911,895</td>
<td>1,834,862</td>
</tr>
<tr>
<td>New York</td>
<td>666,000</td>
<td>782,000</td>
<td>646,760</td>
<td>1,080,378</td>
</tr>
<tr>
<td>Ohio</td>
<td>1,137,000</td>
<td>1,550,000</td>
<td>749,983</td>
<td>1,870,833</td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td>649,000</td>
<td>627,000</td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
<td>577,000</td>
<td>546,000</td>
<td>711,618</td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
<td>298,000</td>
<td>403,000</td>
<td>1,338,265</td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
<td>1,070,574</td>
<td>1,054,542</td>
<td>1,931,030</td>
</tr>
<tr>
<td>Other States</td>
<td></td>
<td>800,866</td>
<td>942,004</td>
<td>1,780,288</td>
</tr>
<tr>
<td>Total</td>
<td>14,497,000</td>
<td>17,486,000</td>
<td>15,692,172</td>
<td>19,414,667</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>1932</th>
<th>1933</th>
<th>1934</th>
<th>1935</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>2,024,315</td>
<td>1,812,188</td>
<td>1,548,341</td>
<td>4,786,881</td>
</tr>
<tr>
<td>Indiana</td>
<td>1,130,440</td>
<td>837,512</td>
<td>1,037,115</td>
<td>2,310,066</td>
</tr>
<tr>
<td>Iowa and Nebraska</td>
<td>444,200</td>
<td>1,123,301</td>
<td>1,266,430</td>
<td>2,784,962</td>
</tr>
<tr>
<td>Maine, Vermont, New Hampshire</td>
<td>1,070,574</td>
<td>1,054,542</td>
<td>1,546,538</td>
<td>1,931,030</td>
</tr>
<tr>
<td>Maryland and Delaware</td>
<td>800,866</td>
<td>942,004</td>
<td>1,369,374</td>
<td>1,780,288</td>
</tr>
<tr>
<td>Minnesota</td>
<td>2,017,770</td>
<td>2,349,736</td>
<td>1,272,242</td>
<td>3,363,148</td>
</tr>
<tr>
<td>New York</td>
<td>495,729</td>
<td>584,343</td>
<td>835,932</td>
<td>1,151,908</td>
</tr>
<tr>
<td>Ohio</td>
<td>405,145</td>
<td>504,882</td>
<td>1,020,453</td>
<td>1,460,856</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>140,203</td>
<td>279,336</td>
<td>687,526</td>
<td>955,853</td>
</tr>
<tr>
<td>Other States</td>
<td>635,972</td>
<td>557,379</td>
<td>410,853</td>
<td>636,588</td>
</tr>
<tr>
<td>Total</td>
<td>9,357,642</td>
<td>10,192,730</td>
<td>11,267,897</td>
<td>21,471,417</td>
</tr>
</tbody>
</table>
Selecting the Corn in the Field

The canning of corn begins with the contract for growing the crop. The factory superintendent keeps a record of the time of planting each field, the character of the land, its exposure, and the date of silking. He must then make frequent inspections as to the progress in maturation so as to direct the harvesting when prime for quality. The natural inclination of the grower, who makes delivery at a fixed price per ton, is to harvest when it is convenient to do so and when the ears have attained their maximum weight, which is after they have passed their prime condition for canning. His interest is in tonnage unless the contract is for payment upon a quality basis. The matter of the kind of soil and exposure is of considerable importance in hilly land, but is of only minor consideration in the level prairie sections. On hilly tracts it may be necessary to harvest even small patches in a field, whereas on the level stretches this is rarely necessary. To gather the ears too soon means a soft and watery pack, and to wait too long means one that is dry and starchy and with tough hulls. The ears do not all set nor mature at just the same date in any field, but during an average period of about ten days. Some ears are a little advanced and some immature, but the majority are in good canning condition for a few days and the advanced and immature stock tend to balance each other. If too high a percentage be soft, it can be given body by the addition of a small quantity of starch, and that which is slightly advanced can be thinned and well precooked, but neither can be made of prime quality. Experience gained by careful observation and many records, fortified by frequent cooking tests, is the best guide for the field superintendent. In all cases of doubt an experimental batch may be made.

Prof. C. O. Appleman,* of the Maryland Experiment Station, made a study of the changes in corn beginning with the pre-milk stage and extending into the dough stage or beyond the point at which it was fit for canning. The pre-milk stage, or that in which the kernels are just forming and the juice is slightly cloudy, gives a good starting point for field inspection. The ears have not attained full size, the husks are close and tender, and the silk partly green. The milk stage follows, the ears being nearly full size, the kernels well formed, and on cutting, the contents escape as a milk or cream. This is the stage most desirable for canning. The next is the pre-

dough stage, in which the contents are beginning to thicken and become more or less sticky. The ears have attained full size and the husks begin to toughen. Corn may be used for canning in this stage, though it has passed its prime for flavor, consistency, and tenderness of hull. The dough stage is just one step nearer maturity, in that the contents are drier, starchy, and like thick dough.

The chemical composition with respect to total sugars and starches in these different stages is shown in the following graph by Appleman.

Relative percentages of total sugars and starch in green sweetcorn at different stages of ripening as indicated by the nail test. The solid columns represent the starch percentages, and the broken columns the percentages of total sugars. Each pair of columns represents a single ear. The ears for each stage of ripening are arranged according to the percentage of water in the kernels, beginning with the highest water content at the left of the figure.

Effect of Temperature on the Rate of Maturation

The effect of temperature in speeding up or retarding these changes is such an important factor that it is shown best in a table from the same work.

"Comparison of early and late crops of sweet corn in respect to changes in percentage composition in equal length of time."

<table>
<thead>
<tr>
<th>Time from first examination</th>
<th>Early Crop</th>
<th>Late Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture</td>
<td>Total Sugars</td>
</tr>
<tr>
<td>0 Days</td>
<td>86.55</td>
<td>5.39</td>
</tr>
<tr>
<td>2 Days</td>
<td>84.21</td>
<td>5.90</td>
</tr>
<tr>
<td>4 Days</td>
<td>80.63</td>
<td>6.89</td>
</tr>
<tr>
<td>6 Days</td>
<td>75.89</td>
<td>6.09</td>
</tr>
<tr>
<td>8 Days</td>
<td>72.05</td>
<td>4.21</td>
</tr>
<tr>
<td>10 Days</td>
<td>70.47</td>
<td>3.75</td>
</tr>
<tr>
<td>12 Days</td>
<td>67.78</td>
<td>3.50</td>
</tr>
<tr>
<td>14 Days</td>
<td>65.51</td>
<td>3.55</td>
</tr>
<tr>
<td>15 Days</td>
<td>64.98</td>
<td>3.02</td>
</tr>
</tbody>
</table>

*Same stage of ripening as late crop on fifteenth day
†Same stage of ripening as early crop on sixth day.
The corn used in these experiments was the same, but one part planted early to develop the green ears in August or during the hottest part of the summer, and the other planted late to develop some weeks later when the weather was decidedly cooler. The early crop passed from the pre-milk stage to prime canning condition in six days, while the late crop required fifteen days, or two and one-half times as long. This means that the period during which it remains in prime condition is correspondingly long, a matter of the greatest importance in the operation of a factory. The deduction is clear that there is a distinct advantage in growing corn for canning purposes well to the north, or if grown toward the southern side of the belt, that the planting be made so as to mature late in the autumn. Another factor enters into the latter consideration, and that is infestation due to the bollworm, late crops in some places being badly damaged, whereas the early crops usually escape its ravages.

Appleman has also constructed another table based on his studies of temperature and maturing of corn which may be taken as a guide for Maryland, and it is believed that the results probably apply to other sections.

**AVERAGE RATE OF SWEET CORN RIPENING**

Calculated from Normal Temperatures at Baltimore, Maryland.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15–31</td>
<td>1−15</td>
<td>15–31</td>
<td>1−15</td>
<td>15–30</td>
<td>1−15</td>
</tr>
<tr>
<td></td>
<td>7 2</td>
<td>8 2.5</td>
<td>9 3</td>
<td>10 3.5</td>
<td>12 4</td>
<td>15 5</td>
</tr>
</tbody>
</table>

The first figure in the second line represents the time from the pre-milk stage until the corn is in prime condition for canning, and the second figure the length of time that it will remain in this condition.

Messrs. Culpepper and Magoon,* of the Bureau of Plant Industry, worked along similar lines and upon corn grown under conditions almost identical with those at the Maryland Experiment Station. They varied their method and took the date of the appearance of the silk as the time from which to reckon the age of the corn. This has the advantage that it can be readily observed. They used fifteen varieties upon which to make their observations. early, medium, and late maturing of both white and yellow types. The white varieties in the order of their maturity were Howling Mob, Crosby, Hickox's Improved, Potter's Excelsior, Kelly’s Hybrid, Mammoth Sugar, Old Colony, Narrow Grained Evergreen, Country Gentleman, and Stowell’s Evergreen; and the yellow varieties in the same order were Golden Bantam, Dreer’s Golden Giant, Charlevoix, Morse’s Golden Cream, and Vaughn’s Bantam Evergreen. It was found that with all these varieties the kernels were too immature on the fifteenth day after silking, and that they passed their prime on the twenty-fifth day. The gross weight of the corn gradually increased until about the twenty-fifth day, and likewise the amount which might be cut from the cob. The sugars increased until about the fifteenth day, then gradually decreased, during which later period there is a corresponding increase in starch. The hull toughens progressively after the fifteenth day. It was found that the period when the consistency was best was between the nineteenth and twenty-fourth days; that prior to that time, the kernel was watery and that later it was doughy. This, therefore, embraces the period for the best canning,

and may be shortened by unusually warm weather or extended by cool temperature. The general conclusion, therefore, confirms that of the work by Appleman.

Variations in Weight of Grain, Cob, and Husk During Development of the Ear

Since Golden Bantam, Crosby, Country Gentleman, and Stowell’s Evergreen constitute such a preponderance of canned corn, some of the data concerning these have been segregated as the rate of growth of the whole and husked ear, per cent of cut corn figured on the whole and husked ear, and per cent of cob and per cent of husk at different dates from the time at which the silk appeared. (From Culpepper and Magoon.)

<table>
<thead>
<tr>
<th>Variety and days from silking</th>
<th>Weight snapped ear</th>
<th>Weight husked ear</th>
<th>Per cent cut corn</th>
<th>Per cent cut corn from cob</th>
<th>Per cent of cob</th>
<th>Per cent of husk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Bantam</td>
<td>Grams</td>
<td>Grams</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Days</td>
<td>91.8</td>
<td>23.3</td>
<td>7.8</td>
<td>30.7</td>
<td>17.5</td>
<td>74.6</td>
</tr>
<tr>
<td>10 Days</td>
<td>152.0</td>
<td>70.0</td>
<td>12.2</td>
<td>26.3</td>
<td>34.0</td>
<td>53.7</td>
</tr>
<tr>
<td>15 Days</td>
<td>155.4</td>
<td>90.0</td>
<td>25.9</td>
<td>44.7</td>
<td>31.9</td>
<td>42.1</td>
</tr>
<tr>
<td>20 Days</td>
<td>176.1</td>
<td>100.0</td>
<td>27.4</td>
<td>48.0</td>
<td>29.6</td>
<td>42.9</td>
</tr>
<tr>
<td>25 Days</td>
<td>187.5</td>
<td>126.0</td>
<td>46.6</td>
<td>68.9</td>
<td>21.0</td>
<td>32.3</td>
</tr>
<tr>
<td>30 Days</td>
<td>194.1</td>
<td>136.0</td>
<td>48.5</td>
<td>68.8</td>
<td>21.8</td>
<td>29.6</td>
</tr>
<tr>
<td>Crosby</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Days</td>
<td>113.0</td>
<td>42.5</td>
<td>15.9</td>
<td>42.2</td>
<td>21.6</td>
<td>62.4</td>
</tr>
<tr>
<td>10 Days</td>
<td>180.9</td>
<td>100.0</td>
<td>22.4</td>
<td>40.6</td>
<td>32.8</td>
<td>44.7</td>
</tr>
<tr>
<td>15 Days</td>
<td>192.9</td>
<td>123.7</td>
<td>21.5</td>
<td>33.7</td>
<td>42.6</td>
<td>35.8</td>
</tr>
<tr>
<td>20 Days</td>
<td>255.0</td>
<td>170.0</td>
<td>37.2</td>
<td>55.8</td>
<td>29.4</td>
<td>33.3</td>
</tr>
<tr>
<td>25 Days</td>
<td>212.5</td>
<td>166.2</td>
<td>47.0</td>
<td>60.0</td>
<td>31.2</td>
<td>21.7</td>
</tr>
<tr>
<td>30 Days</td>
<td>227.5</td>
<td>168.7</td>
<td>47.8</td>
<td>64.4</td>
<td>26.3</td>
<td>25.8</td>
</tr>
<tr>
<td>Country Gentleman</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Days</td>
<td>103.1</td>
<td>43.5</td>
<td>20.6</td>
<td>48.9</td>
<td>21.5</td>
<td>57.8</td>
</tr>
<tr>
<td>10 Days</td>
<td>191.6</td>
<td>115.0</td>
<td>21.9</td>
<td>36.5</td>
<td>38.0</td>
<td>40.0</td>
</tr>
<tr>
<td>15 Days</td>
<td>216.0</td>
<td>153.0</td>
<td>29.4</td>
<td>41.5</td>
<td>41.4</td>
<td>29.1</td>
</tr>
<tr>
<td>20 Days</td>
<td>253.5</td>
<td>192.0</td>
<td>46.1</td>
<td>60.9</td>
<td>29.6</td>
<td>24.2</td>
</tr>
<tr>
<td>25 Days</td>
<td>257.0</td>
<td>211.5</td>
<td>55.8</td>
<td>67.8</td>
<td>26.4</td>
<td>17.7</td>
</tr>
<tr>
<td>30 Days</td>
<td>216.5</td>
<td>183.5</td>
<td>60.7</td>
<td>71.6</td>
<td>24.0</td>
<td>15.2</td>
</tr>
<tr>
<td>Stowell’s Evergreen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Days</td>
<td>216.4</td>
<td>97.6</td>
<td>15.3</td>
<td>34.0</td>
<td>29.7</td>
<td>54.9</td>
</tr>
<tr>
<td>10 Days</td>
<td>328.5</td>
<td>194.0</td>
<td>18.8</td>
<td>31.9</td>
<td>40.2</td>
<td>40.9</td>
</tr>
<tr>
<td>15 Days</td>
<td>327.5</td>
<td>238.3</td>
<td>28.7</td>
<td>29.5</td>
<td>44.0</td>
<td>27.2</td>
</tr>
<tr>
<td>20 Days</td>
<td>411.6</td>
<td>320.0</td>
<td>45.9</td>
<td>59.1</td>
<td>31.8</td>
<td>22.3</td>
</tr>
<tr>
<td>25 Days</td>
<td>418.3</td>
<td>321.6</td>
<td>52.1</td>
<td>67.8</td>
<td>24.7</td>
<td>23.1</td>
</tr>
<tr>
<td>30 Days</td>
<td>474.0</td>
<td>414.0</td>
<td>62.8</td>
<td>72.6</td>
<td>23.6</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Prof. A. T. Erwin, working along a somewhat similar line, reports as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield per acre snap corn</th>
<th>Yield per acre cut corn</th>
<th>Per cent cut corn</th>
<th>Per cent cut corn from cob</th>
<th>Per cent of cob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Evergreen</td>
<td>4.35</td>
<td>1.48</td>
<td>34.1</td>
<td>31.2</td>
<td>34.6</td>
</tr>
<tr>
<td>Stowell’s Evergreen</td>
<td>4.93</td>
<td>1.62</td>
<td>33.2</td>
<td>30.3</td>
<td>36.4</td>
</tr>
<tr>
<td>Country Gentleman</td>
<td>4.33</td>
<td>1.40</td>
<td>32.7</td>
<td>31.7</td>
<td>35.6</td>
</tr>
</tbody>
</table>
Variation in Composition of the Grain During Development

The chemical composition of the same varieties, sampled at the same dates, is likewise interesting.

### Physical Test of the Grain

Consistency is an important factor in the finished product, and is dependent very largely upon the quantity of starch present and the toughness of the hull in the green corn. A rough test employed by most superintendents is the thumb-nail test, or the pressure required to break the hull.
with the thumb-nail. This is subject to a variable personal equation which makes close comparison by different persons out of the question.

Culpepper and Magoon devised a simple pressure tester so that the force required to make a puncture with a standardized needle might be measured and recorded, an adaptation of a principle applied to corn by R. A. Rudnick and A. L. Bakke (Iowa Academy of Science, 1920, p. 129) and already in use on some fruits. This was also used in these tests and shows a pretty close relation to the composition.

Harvesting

The ear is harvested by snapping it from the stalk, the succulent condition of the stem at that time making this an easy operation by a slight downward jerk. The nubbins and obviously soft ears are left on to mature with the stalks or to go into silage. In all large operations the fields are stripped at one time, and as all ears do not mature at the same time, some are rather advanced and others immature. The ears are thrown directly into the wagon to be hauled to the factory. The usual rule is to use the standard wagonbed with added sideboards to give a depth of four or even five feet. The weight on the bottom layer of ears under these conditions is considerable and may be injurious. Fortunately, it does not take long to snap a load, otherwise there would be a tendency to heat, due to the tight packing, which happens whenever a load stands overnight. Theoretically, at least, it would be better to use wider beds with less depth, and this practice is gaining in favor. The style of rack used in Minnesota is described as being about eight by fourteen feet, and with sides from one and one-half to two feet high, holding about two tons. In emergencies these wagons can be used for storage. Ventilating the bed by separating the bottom boards five-eighths of an inch is a further attempt at heat prevention, though the sharp edge of the boards may easily do more harm than the good from ventilation. The mere fact that one does not see the injury to the ears, due to the superimposed weight or sharp edges, does not lessen the possibilities in that direction. Corn spread in a thin layer over the ground during the night suffers little by comparison with that which is left in heaps.

The snapping of the corn is best begun early in the morning, the corn then brought to the factory promptly and the gathering stopped by the middle of the afternoon, so that all corn may be canned the same day rather than carry the corn over night as was formerly done and still is in some places.

Changes in Corn After Harvesting

The changes which take place after snapping occur more rapidly than can be appreciated from a mere inspection of the unhusked ears. These are of two kinds: the one is the change of sugars into starch, with the accompanying toughening of the fiber, and the loss of flavor, and the other is the bacterial invasion of the normally sterile ear. Straughn and Church,* of the Bureau of Chemistry, were the first to investigate the change in composition in 1905 to 1908. Their work was summarized by Dr. Wiley as follows: "The content of sugar in sweet Indian corn rapidly diminishes after the ear is separated from the stalk. The speed of the diminution

depends largely upon the temperature, being more rapid with a higher and slower with a lower temperature; this rule, of course, applies to ordinary conditions.

"The chief value of Indian corn for the table is found in its sweetness, although this must be coupled with succulence and tenderness. The flavor of the naturally sweet Indian corn cannot be successfully imitated by the artificial addition of sugar. Hence it follows that there is some particular form in which the sugar is combined by nature in the corn which gives it its high value, and mere sweetness, produced either by added cane sugar or by saccharine, does not give the fine flavor of a naturally sweet product."

Later Appleman and Arthur* worked along the same line and came to a like conclusion, summarizing their results as follows: "The depletion of sugar in green corn after it is separated from the stalk does not proceed at a uniform rate, but becomes slower and slower, until finally the loss of sugar ceases when the initial total sugar has decreased about 62 per cent and the sucrose about 70 per cent." When depleted, the corn contained 1.5 per cent total sugars, 0.7 per cent as sucrose, and 0.8 per cent as free reducing substances.

These investigators took prime corn and held it at 86, 68, 50, and 32° F. The corn held at 86° lost 50 per cent in 96 hours. That held at 68° lost 25 per cent in the first 24 hours, and over 45 per cent in 48 hours. At 50°, the losses were about 16 per cent in the first 24 hours, and 50 per cent in 96 hours, and at 32° the losses were 7 per cent the first 24 hours and about 20 per cent in 96 hours. The sugar had been largely converted into starch, so that while the nutritional value had not been much impaired, there was loss in flavor, an increase in starchiness, and a toughening of the hull.

**Microbial Infection**

Although corn was one of the first products to be studied bacteriologically to determine a safe time and temperature for cooking in the cans, very little has been done upon the microbial changes which occur between the time of plucking and just prior to processing. It is known that microorganisms increase more or less rapidly on corn while standing, and this is recognized in a practical way in the factory by increasing the process upon material which has been carried over night or gathered on very hot days. The grains on the normal ear while attached to the stalk are sterile, and ears infected with the bollworm show sterility of the grains very near to the worm or to the track made by it. Katherine Golden Bitting† made many examinations and found sterile grains within a half inch of such foreign invasion. When the ear is removed from the stalk, bacteria which are on the surface of the husks soon multiply and invade deeper tissues. This is aided by high temperature and moisture as developed by the respiration from the green corn when in a pile. Bruising of the tissues due to throwing the ears in a wagon, hauling, or superimposed weight favor the multiplication of organisms, and while many may not reach the kernels directly, they become inoculated upon the grain in the subsequent work of husking, and from the increased number which ultimately become dis-

---

†Paper read at meeting of Pacific Division, A. A. A. S., 1926.
tributed upon conveyor belts and other mechanism. Holding, therefore, adds to the amount of infection either directly or indirectly, and increases the difficulties in sterilization.

A paper* from the Bureau of Chemistry is interesting, though the amount of work done is evidently too small to be more than indicative of what may occur. The following is quoted: “In an examination of 10 ears of fresh corn, dextrose agar plates incubated at 30° for two days revealed an average of 30,000 organisms per kernel of corn. Plates incubated at 55° C. for two to four days showed an average of one heat-resistant organism per kernel. A rough estimate of the number of bacteria on kernels taken from different points on the cob showed a very heavy contamination around the base of the ear, consisting of practically one type of organism, very little contamination at the tip, and that of a different type of organism, and a moderate mixed contamination in the middle. A similar examination of the husks showed decreasing numbers of organisms with increasing depth toward the kernels.”

Since it takes on an average of six grains to weigh a gram, this would indicate a normal infection of 150,000 or more bacteria per gram.

U. S. Grades

U. S. STANDARDS FOR SWEET CORN FOR CANNING
(Effective February 21, 1935)

Introduction

These standards are recommended to be used as a basis for contracts only after thorough consideration by canners and growers, and preferably after demonstration of methods of grading and inspection by qualified inspectors. They provide a basis for sampling the corn as it is delivered to the cannery in order to determine the amounts of husked ears of U. S. No. 1 or U. S. No. 2 corn in any lot, and to determine the relative maturity of various lots of corn as indicated by the proportionate amounts of “Class A,” “Class B,” and “Class C” ears in the husked corn.

All percentages shall be determined by weight.

Percentages of U. S. No. 1 and U. S. No. 2 ears of corn shall be based on the relationship between the husked ears of these grades and the total weight of the sample of corn in the husk. For example, the weight of a sample in the husk is 50 pounds and the weights of U. S. No. 1 and U. S. No. 2 corn after husking are 31 and 3 pounds, respectively, making a total of 34 pounds. The total weight of U. S. No. 1 and U. S. No. 2 husked ears, or 34 pounds, is 68 per cent of the 50-pound sample of corn in the husk.

The proportionate amounts of “Class A,” “Class B,” and “Class C” ears shall be based upon the relationship between the total weight of the U. S. No. 1 and U. S. No. 2 husked ears, and the weight of the ears in each of the maturity classifications. For example, the total weight of U. S. No. 1 and U. S. No. 2 husked ears is 34 pounds. After separating the husked ears into each of the maturity classifications it is found that 16 pounds of ears meet “Class A,” 15 pounds meet “Class B,” and 3 pounds meet “Class C” requirements. The 16 pounds of “Class A” ears is 47 per cent of 34 pounds, 15 pounds of “Class B” is 44 per cent, and 3 pounds of “Class C” ears is 9 per cent.

The standards may be used as a basis for the purchase of sweet corn regardless of whether the canner wishes to pay for the sweet corn in each load according to the amount of cut corn, corn on the cob, or ears of corn in the husk.

Contracts based upon the standards should contain a special provision for paying for corn harvested in accordance with canners' instructions when such instructions prevent growers from securing more favorable prices established in the contract for corn of a specified maturity.

The following illustrates one method by which corn may be purchased on the basis of the U. S. standards.

*James, Lawrence H. Bacterial Control of Sweet Corn. “Canning Age,” June, 1925, p. 561.
Assume that a canner wishes to pay for only the husked ears of U. S. No. 1 grade in each load. He also desires to pay different prices for loads of corn of different stages of maturity. He may wish to pay a premium for loads which have a high percentage of young and tender corn. For loads of average maturity he may want to pay at about the average rate for such corn as received in the past. For corn that is too far advanced in maturity to be desirable for good canned corn he may wish to establish a suitable penalty.

Then the contract between grower and canner should state that the canner will pay for only the husked U. S. No. 1 ears in each load, the price for such ears to be based upon the percentage of Class A ears in the husked corn. Canners who want young, tender corn should establish a premium for sweet corn having a large percentage of Class A ears, while a price the same as that which would have been paid for sweet corn if purchased at a flat rate should be specified for corn having only a medium percentage of Class A ears, and a suitable penalty should be established for loads having a very small percentage of Class A ears.

The application of these standards requires the services of private or official inspectors to determine the amounts of each grade of husked corn in the various loads and the percentages of Class A, Class B, and Class C ears in the husked corn. Such inspectors must be capable, efficient, and above all, they must be absolutely neutral.

Numbers and parentheses following grade terms indicate where such terms are defined on page 9 under Definitions of Terms.

**Grades**

*U. S. No. 1* shall consist of ears of sweet corn which have similar color characteristics (1) and which are free from freezing injury and from serious damage by cross-pollination (2) and smut (3).

Unless otherwise specified, each cob shall have not less than 3 inches of its length practically filled with uninjured kernels or the equivalent of this amount, which can be salvaged in the ordinary process of commercial trimming (4).

Kernels shall be sufficiently mature but not overmature for canning purposes and shall not be appreciably dented from over-maturity.

*U. S. No. 2* shall consist of ears of sweet corn which meet the requirements of U. S. No. 1 grade except that they are appreciably dented from over-maturity.

**Maturity Classification of Husked U. S. No. 1 and U. S. No. 2 Ears**

*Class A* shall consist of ears of sweet corn the kernels of which are tender (5) and milky.

*Class B* shall consist of ears of sweet corn the kernels of which do not meet Class A requirements for tenderness or which have developed beyond the stage at which the kernels are milky and the exudate is of a heavy consistency, but the kernels are not appreciably dented from over-maturity.

*Class C* shall consist of ears of sweet corn which are appreciably dented from over-maturity.

**Definitions of Terms**

As used in these standards:

(1) "Similar color characteristics" means that the ears of corn in any lot are of the same general color.

(2) "Serious damage by cross-pollination." An ear shall be considered as seriously damaged by cross-pollination when it has more than 10 per cent of kernels of a color which is materially different from that of the majority of kernels on the ear.

(3) "Serious damage by smut." An ear shall be considered as seriously damaged by smut when a gall is broken, or will probably become broken in the ordinary process of machine husking.

(4) "Uninjured kernels which can be salvaged in the ordinary process of commercial trimming." In the ordinary process of commercial trimming it is often necessary to trim away some uninjured kernels with the injured ones. As these uninjured kernels constitute a loss in commercial trimming they are considered as waste when determining the percentage of uninjured kernels which can be salvaged from a cob.

(5) "Tender" means that the kernels break with only moderate pressure from the thumb-nail.
Distributing Corn to Huskers

When the corn is brought to the factory, it is generally dumped on a conveyor to distribute it where it is wanted for husking. Corn is heavy, and the ears cling together to a certain extent, so that it is not easy to manipulate by hand. In small factories, it was formerly dumped or thrown on the husking floors, and this was particularly true where hand husking was followed. In one of the largest factories in the country, the corn was hauled on a runway to the second story and dumped so that it would drop to the huskers below. In another form, runways are built about four feet above the floor, so that the corn can be dumped and pushed to either side and thus save the labor of throwing it off the wagon. In most factories at present, whether large or small and husking be done by hand or machine, the corn is distributed by a power conveyor. The weighed load of corn is driven over a dump, where the corn falls on a chain with wooden flights, the corn being elevated to whatever height is desired above the huskers, and deflectors turn it into inclined shallow bins to avoid bruising the ears. Some skilful engineering has been shown in the designing of sheds and conveyor systems to economize in space, construction, and power required, while at the same time obtaining a high efficiency and convenience in handling the raw product and the waste.

Husking

Husking is now done almost wholly by machine, as one operator will do more than ten men at hand work. It is the latest of the important labor-saving devices in the canning industry and its work has been brought to such a degree of perfection that it does better work than the average man. Its introduction has had a secondary effect of the greatest importance, the elimination of the transient labor element which was uncertain and unsatisfactory. It has added to the sanitary feature in that the husked corn is carried at once by conveyor to the washer and cutters, whereas it was formerly placed in baskets and might remain there for considerable time.

The principle involved in most huskers is that of a pair or pairs of small rollers made to revolve towards each other at a rapid speed. The rollers are spaced so that an ear cannot go between them, but the friction of the rollers against the ears loosens the husk so that it will be caught between the rolls and torn off. In some machines the rolls are covered with tough rubber, but finished to have a rather rough surface. In the other style, having metal rolls, the surface is lightly milled. Whether the rolls be of rubber or steel, they are mounted so as to spread to permit husks to pass between them and then return instantly, due to the action of springs. They are slightly wider apart at the upper end where the heavier, outer, and majority of husks are torn off, and touch at the opposite end. Rubber rolls are brought together with sufficient tension to compress the meeting surfaces about a sixteenth of an inch. In a still different type of machine, the rolls have eccentric mountings. The rapidly revolving rolls impart sufficient motion to the ear to cause the husks and silk to fly outward, so that nearly all the silk comes away with the husk. As an aid to loosening the husks and to prevent interference later in the cutting machines, the ears are nearly always butted before they are permitted to come in contact with the husking rolls. The rolls are kept constantly wet with a small stream of water, otherwise they become foul from the husk juices.
The corn is not treated as gently as in hand husking, but the injuries are of little consequence if the succeeding steps are followed without delay.

Different schemes have been evolved for getting the corn to the huskers to expedite feeding. One has upright bins into which the corn is delivered from the conveyor with an opening left at the bottom for the removal of the ears. The objection is that the ears wedge so tightly from the superimposed weight that they cannot be removed rapidly or with ease at all times. Its advantage is in the conservation of space. The chute and table consist of an inclined broad shelf with the sides drawn in to a width of about two and one-half feet, thus delivering the corn to a point where it is easily reached by the feeder without effort. The corn is brought to the chute by means of a conveyor and diverted into the receptacle by means of gates which may be operated by the feeder. In one type the conveyor passes directly in front of the husker, and the feeder picks the ears as they are passing. About ten or twelve machines can be set along one belt. The difficulty is in getting the right amount of corn at all times to keep the machines working at maximum capacity. If more than twelve machines are required, it is better to use more belts than to increase the load on one.

The husked ears are discharged on a short inclined chute or directly onto the conveyor belt. Between two and five per cent of the ears require some hand work in removing bits of husk, and a helper may stand at this discharge end to clean these ears, to assist in getting the corn down, relieve the feeder, etc., or the ears may be freed of bits of husk by the inspectors. The efficiency of a husking machine depends wholly upon how rapidly and constantly it is fed, so that many superintendents prefer to have an operator and helper for each one rather than depend upon one operator only.

The husks constitute approximately one-third the weight of the unhusked ear, are loose and bulky, and are either removed on the return portion of the corn conveyor belt or on a separate conveyor. The return portion of the main conveyor, or sometimes that of the ear conveyor, is dropped into a groove at the level of the floor to receive the husks and carry them to a point where they can be discharged on another which will lead outside the building. The use of these conveyors may be an economy at times, but there are objections to the use of the husked corn conveyor for this purpose which should not be dismissed lightly, the principal one being the matter of cleanliness. The husked corn conveyor should be strictly clean, and it is not usually found in that condition when the under side is used to carry the husks. One of the distinct advantages in machine husking over hand husking is that there is no accumulation of either corn or husks to keep up constant incipient fermentation.

Husking is a much dirtier operation than would be suspected by persons not familiar with the work. During hot, dry weather in August and early September a considerable amount of dust accumulates on the surface of the ears, and it is loosened by the conveyors, in sliding into bins, and by the action of the husking machines. For this reason it is better that the husking shed be separated from the preparatory work in the factory. If the work be done in the same building, solid partitions should separate the two departments. In the desire to secure compactness in factory construction or close superintendence of operations, this step may be connected too closely with that which follows.
It usually requires two husking machines for each cutting machine or twelve for a one-line plant operating at about one hundred cans per minute. It is claimed for the latest type that three huskers equal the capacity of two cutters.

Inspection

After the corn is once delivered on the conveyor belt the procedure may vary somewhat according to the space available and the arrangement of the equipment. In some plants the attempt is made to make the inspection as nearly complete as possible, to remove the attached husk, soft ears, and to do all the trimming of immature tops, bad butts, worm paths, etc. In other plants, the soft and hard ears, and crooked nubbins are removed and the trimming done after the ears pass through the washer, as that device removes many pieces of husk, clumps of silk, and debris, and thus reduces the amount of hand labor. The objection most often urged against this course is that the corn is handled after being washed, but this point is easily met by spraying the corn as it passes to the cutter.

All the corn will not mature uniformly, so there is always some immature ears and some too advanced for the best grade, and these must be separated. If the factory be small, they are held until a sufficient quantity accumulates to make a batch, while in large factories they are diverted into a separate line. Imperfect tips and butts should be cut off, and for this purpose the revolving discs are preferable to striking with a knife. The removal of debris due to the bollworm can be done only with the knife, and to leave any brown grains constitutes gross negligence. The number of persons required for inspection on a line will depend upon the condition of the raw material.

Silking and Washing

The brush silker was standard equipment when hand husking was the rule but is being largely supplanted by sprays for that which is machine husked. This apparatus consists of a series of parallel rolls in pairs, which, revolving at high speed, impart a similar motion to the ear, causing the silk and bits of husk to be thrown out by centrifugal force, while at the same time adjustable brushes rotating at right angles to the long axis of the ear, remove any particles which may be on the surface. A spray of water aids in this work. Since the husking machine spins the ear and does part of the work of this type of silking machine, a simpler mechanism answers and is rapidly taking its place. This consists of a washer employing the principle of sharp sprays of water operating under a pressure of fifty pounds or preferably more. The sprays are arranged to strike every part of the ear or the ear is made to turn over so that it is exposed on all sides. A booster pump may be necessary to get the effective pressure, but when once obtained, it is the best method yet devised for removing the silk, since it not only gets the bits upon the surface, but a considerable part of that between the rows, and at the same time gives the ear a thorough washing. If the water pressure be low, the efficiency as a silking device is almost nil. The corn may be carried between sprays on a wire mesh belt or the work be done in the cylindrical type of washer.
Conveyors

The conveyor, or that portion where the inspection of the husked corn is made, should be of sufficient width so that the ears are not piled upon each other, and the travel not faster than permits a proper examination of the ears. In the larger factories, the inspection portion of the conveyor may be divided by a board suspended from above, so that the prime stock will pass directly on the line and the lower grade be tossed to the narrow portion of the belt and diverted to another. Corn is inherently difficult to keep clean, as any bruising of grains, cutting of cobs, mashing of silks between the belt and the trough, cause juice to be freed, which becomes sticky on exposure to air and partial drying. In addition, the juice contains a sufficient amount of sugar to be easily fermentable and becomes infected with innumerable bacteria, so that the belt should be the kind to stand frequent applications of water and steam and be washed at intervals with hot cleaning solutions. A good rubber belt, preferably white faced, is probably the best. A canvas belt is an abomination as is also the wooden slat belt. The woven monel metal belt is highly recommended, but affords a refuge for organisms, so needs frequent washing.

Cream Corn and Whole Grain Corn

At this point the packing of corn proceeds along two distinct lines, cream corn or Maine style, and whole grain or Maryland style. The former had its origin with Winslow in Maine. The grains are cut to a predetermined depth and the pulp scraped from the base which adheres to the cob. This pulp is mixed with the kernels and gives the creamy consistence characteristic of this style. The latter probably had its origin with Kensett in Baltimore. The grains are cut off as nearly whole as possible, bits are sieved out and the kernels retained whole in brine. This style really preceded the cream corn in point of origin but was abandoned by most packers as not well suited to the broad grained varieties of sweet corn then in use, and for the further reason that the earliest machines were better adapted to handle the cream style. Another rather important factor was the high cost of cans, and by adding the pulp more corn and less water was packed.

The whole grain style of packing was favored by a few packers in Maryland who grew a long narrow-grain variety of corn. This style of packing, however, involved a much greater amount of labor as all the cutting had to be done by hand which naturally tended to restrict the volume. Within the past ten years suitable cutters and other machines have been developed to do this work and coincident with these has been the great increase in this style of packing.

The factory equipment and methods used in producing the two styles of corn are so different that they are considered separately.

Cutting

The earliest cutter was a long-bladed butcher knife, and that instrument is still in use in a few small whole-grain canning plants. The cutting differs from that in the kitchen in that the women wear a small board suspended from their necks, against which the ear, seized with the fingers of the left hand, is pressed. Five dextrous strokes of the knife suffice to remove the kernels. The cut at either end is not to the full depth of the
kernels while that in the center may penetrate into the cob. It is really marvelous the speed with which the work is done by experts.

The first improvement was a knife with a curved blade and a guard to regulate the depth of the cut. The reason for this is apparent when one remembers that the greater part of the corn then in use had a broad flat grain. The guard limited the tendency to cut into the cob and gave a greater uniformity to the kernels. The back of the knife was used to scrape the pulp from the base of the kernel which was attached to the cob.

The advantages of the curved blade and guard were so obvious that they were retained in the subsequent mechanical developments. In 1866, a cutter was invented in which the knives were mounted in pairs on rigid supports, but the blades permitted to spread apart and close down to accommodate the cutting to ears of different size. Two or three pairs of knives were mounted so as to completely encircle the cob. A guide trough and a plunger were used to direct and force the ear against the knives. It was not until 1882 that Welcome Sprague improved upon his predecessors by providing a continuous drive to force the ears between the cutters and added blunt rotating scrapers to remove the pulp. This greatly increased the cutting capacity and efficiency of the machines, and while many detail improvements have been made since, the fundamentals remain the same.

In 1928, the plunger type of machine was modernized by up-to-date engineering methods and made so efficient that there are as strong partisans among the users of the machines as among the manufacturers.

The washed ears are conveyed to the cutting room where the arrangement is similar to that in the husking shed, but on a smaller scale. The ears are elevated above the cutting machines by means of the belt conveyor, and discharged into small inclined bins so as to direct the corn to the most convenient point for feeding and to cause the least movement on the part of the operator. In some cases the feeding is done directly from the conveyor belt, which would seem to be the ideal method, though it requires a balancing of parts and co-ordination that are difficult to attain. The objections which can be urged against the bin method are decidedly more theoretical than practical if reasonable care be used in keeping everything clean.

The ears are placed tip forward on the cutting machine, and while this is not necessary, the work done is a little better. The knives expand with the taper of the ear and do a closer job of cutting than when contracting under pressure of the springs. The speed of the machine is greater than that of the operator to feed it. Hand feeding affords an opportunity for inspection for defective ears that may have been missed on the inspection belt.

The cutting knives are limited in the depth of cut by a feeder guard, and in the case of long-grained corn, one set of knives takes off the outer portion of the grain and a second series takes off a deeper section. A series of arms is also provided with blunt blades to act as scrapers to remove the pulp from the part of the kernel remaining on the cob, and this is added to the cut portion.

The depth of the cut is regulated to a certain extent by the variety of the corn and the style of packing that is wanted. In cream style of pack-
ing the broad shallow-grained varieties, like Crosby, are cut to a depth of one-eighth of an inch, while a deeper grain may be cut to a depth of three-sixteenths of an inch for a single cut. Deep grained corn, such as Stowell’s Narrow-grain or Country Gentleman, may be cut twice, but the effect is always more mushy than a single cut. A deep cut on a broad-grained corn means the removal of some of the chit or chaff from the cob, which damages the appearance and also adds a trace of bitter flavor. Double cutting instead of recutting is now used on corn which is a little too far advanced for prime quality.

The use of slitting knives to cut the ends of the grains, so that the contents can be squeezed out, or a combination of slitting and cutting, is a later development, and will be discussed in another paragraph. The important thing with corn cutters is that the knives be kept very sharp, so they do not make ragged cuts or tear grains loose from the cob, which is likely to occur at the base if the blades be dull. They require sharpening about every six hours.

It requires six cutters to handle the corn for a single line, operating at the rate of one hundred cans per minute. Five machines will suffice if attended by good feeders, but do not give sufficient leeway for accidents, shutdowns, irregular delivery, or poor corn.

The cutters discharge the cut corn in covered conveyors, and it is desirable that the cutters be so arranged that one conveyor will handle the cut material from several machines or that it be discharged through short pipes directly into the silker. Corn presents a special problem in that the starchy juice becomes sticky after a very short exposure, so that it should be handled in the most direct manner possible. The ear can be handled more easily than after cutting, and it is therefore better that the ears be elevated to the highest point and let the cut material discharge by gravity through short tubes to the silkers and mixers than to use long conveyors and elevators to the latter. The main objection to distributing machinery on two or more floors, and especially in small plants, is that it makes close supervision on the part of the superintendent more difficult, but the advantages and disadvantages must be balanced against those of conveyors, and the latter have not reached a stage of perfection where they can be kept strictly clean. By careful planning of the layout and the use of mezzanine floors for silkers and batch mixers, the use of conveyors can be reduced to the minimum.

The cutting department should have an abundance of light, so that the feeders can detect anything which may need their attention without making a special effort; the floor should be water-tight and pitched for quick draining, and the side should also be made tight up to a height of four feet. There is always some throwing of bits of corn and cob by the machines, and unless this is thoroughly hosed down after each stoppage, fermentation quickly develops. The present cutters are models of cleanliness as compared with those of a few decades ago, but frequent washing is necessary.

The cobs are carried away in special chutes or conveyors and run through a crusher to reduce them to the smallest volume. They constitute slightly more than one-third of the weight of the unhusked ear.
Silking

The greater part of the silk is removed either by washing or the silk brushing machine, if one be used, but there is always a certain amount which lies so deeply between the rows of grain that it cannot be disengaged until the kernels are cut, which requires that a supplementary treatment be given. There are also bits of husk and cob that get into the corn during the cutting and which must be removed. The simplest device for getting rid of this objectionable material is the use of two cylindrical or polyhedral screens, one slowly rotating within the other, and both set on a slight incline. The cut corn is fed into the inner screen and drops through, the large bits pass over the end, and the silk is caught on the wires. The principle involved was one of the first to be employed, and while many others have been tried, this one being efficient continues and is made a part of most of the present devices. An ingenious device formerly used consisted in the use of a rotary screen which let the corn fall through a set of wires extending horizontally from a moving belt, the bits of silk caught on the wires were carried around to another section, where they were knocked off. The latest and most efficient machine utilizes the revolving screen above sets of horizontal vibrating wires provided with a scraper to remove the silk. It is simpler and more rugged than its predecessor. These machines need to be treated to a hose bath at frequent intervals because of the sticky nature of the corn. Supplemental silking is also done in the batch mixer and the pre-heater. Wire wisps are arranged to dip into the corn while it is being mixed and small bits of silk adhere to them.

As already noted, in the Maryland style of packing the silk is blown out by means of a modified fanning mill.

Batch Mixing

The corn after it passes the silker is ready for delivery into the mixing tanks and then into the precooker. While batch mixing and pre-cooking were developed early in the seventies, they have not been given the detailed attention which they deserve, nor by those who have been trained in the art of cookery. The attempt has been to make the operations almost wholly mechanical, working to a schedule of so many pounds of corn and so many gallons of brine with variations according to the rating of the corn as indicated by the field superintendent. Such a schedule is better than none, but it is not a good substitute for judgment which comes with proper training. Corn varies in consistency and flavor according to its state of maturity, to some extent with the variety, and to a slight extent with the time which elapses after snapping, so that some variations need to be made in the proportions as well as in the time of pre-cooking, and these must be based upon the judgment of the operator at this point if a nearly uniform product is to be the result. A rigid schedule can be followed with about the same degree of success as might be anticipated from a dozen cooks of like experience in following a recipe.

There are two types of mixing tanks, vertical and horizontal, both equipped with mechanical stirring devices, and may or may not be heated. Each has certain advantages and disadvantages, but what should not be overlooked is the accessibility and ease with which the apparatus can be cleaned. The mixing tank must serve primarily as the mechanism for collecting definite amounts of corn and brine, or corn, sugar, salt, and water,
each added separately, and mixed uniformly. There is an advantage in heating the mixture to a definite temperature, as the blending takes place better when hot, and one can judge better what the final result will be. The corn has to be heated before entering the can, and by doing this in the mixing tank the foam will be more nearly eliminated, the temperature made slightly higher, and the body somewhat smoother than if heated only in the filler. If the heating be done with perforated pipes, as is commonly the case, a certain amount of water is added by the condensing of the steam, for which allowance must be made. If the heating be done by means of a closed coil or a jacket on the mixing tank, more or less trouble will be experienced with corn sticking on the surface when the batch is drawn off, and thus adding to the trouble in cleaning. Batch tanks are set preferably in pairs so that one is being prepared while the other is being drawn off into the cans.

Making the brine separately adds another unit, but permits it to be strained before using, an advantage which is apparent to anyone who has boiled salt and sugar solutions. There is a certain amount of scum and debris from the bags, no matter how carefully these are handled, and their addition to the corn is objectionable. The addition of the salt and sugar to the corn by weight is the simpler procedure, and admits of variations being made with the minimum of trouble. The batch tank may be marked for a definite number of pounds at certain heights and the corn filled to the mark before any other addition, then the water or brine metered in to within a couple of gallons of the estimated amount and the final adjustment made according to the requirements to get the proper consistency.

Some mixing devices are made continuous; that is, the corn and brine are run in by two pumps capable of being adjusted to any ratio selected. The mixing is done with an agitator and a continuous flow is made to run into the pre-heater. It is doubtful whether the product thus obtained can be made as uniform as when made in batches.

The size of the batch mixer should be such that each unit may be made up and thoroughly mixed and heated without haste. A recent catalog shows these tanks to have a capacity of one hundred gallons, whereas formerly they were built for thirty gallons. One pair suffices for a one-line plant.

The mixing devices are usually made of galvanized iron, but in all probability this will be changed to glass-lined, monel metal or stainless steel equipment in the future.

The Batch

In the mixing of a batch, water is added to the corn at the rate of about one part by weight of the former to four of the latter under average conditions. The proportion is a little less for tender corn and a little more for that too mature and also varies with the consistency desired as moist, medium, or dry. The salt used in the brine is generally about two and one-half per cent, the sugar five per cent, but these, especially the sugar, are varied to suit the taste. Five per cent sugar in the brine is only slightly in excess of that in the corn, so diluting that which is normally present is avoided. There has been a general tendency to increase the amount of sugar to the point where the added sweetness is in such excess as to mask the natural flavor of the corn. More sugar is always used in a fancy grade than in the lower grades, and sometimes this is the only difference which distinguishes
the one from the other. As already indicated, these ingredients may be boiled, filtered, and added as a standardized brine or they may be added directly to the batch of corn.

The following table was compiled from data concerning corn canned during the war and gives a pretty clear picture of the practice at that time in the different states. The sugar is a little low, owing to wartime restrictions. Similar piecemeal data obtained since show so little difference as not to warrant a separate table.

<table>
<thead>
<tr>
<th>Brine 100 gallons</th>
<th>Sugar</th>
<th>Salt</th>
<th>Cases</th>
<th>Time of process</th>
<th>Temperature of process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs.</td>
<td>lbs.</td>
<td>packed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>70</td>
<td>20</td>
<td>100</td>
<td>70 Min.</td>
<td>250° F.</td>
</tr>
<tr>
<td>Indiana</td>
<td>45</td>
<td>22</td>
<td>95</td>
<td>75</td>
<td>248°</td>
</tr>
<tr>
<td>Iowa</td>
<td>41</td>
<td>23</td>
<td>108</td>
<td>70</td>
<td>250°</td>
</tr>
<tr>
<td>Maine</td>
<td>75</td>
<td>7.5</td>
<td>95</td>
<td>70</td>
<td>250°</td>
</tr>
<tr>
<td>Minnesota</td>
<td>41</td>
<td>12</td>
<td>140</td>
<td>70</td>
<td>245°</td>
</tr>
<tr>
<td>New York</td>
<td>45</td>
<td>17</td>
<td>140</td>
<td>70</td>
<td>245°</td>
</tr>
<tr>
<td>Ohio</td>
<td>53</td>
<td>28</td>
<td>121</td>
<td>70</td>
<td>250°</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>40</td>
<td>28</td>
<td>107</td>
<td>75</td>
<td>245°</td>
</tr>
</tbody>
</table>

When corn is too immature or has been harvested early, so as to avoid injury from frost, it is soft and watery, and under these conditions the addition of a small quantity of starch is permissible to give it the proper body. The determination of such a necessity, as well as the amount of starch to be used, lies with the packer, and is covered by a Federal food and drugs regulation.

Preheating

Since preheating is a necessity in the packing of cream style of corn, the preheater is made a part of the filling device. If heating be done in the batch mixer, then the preheater serves to keep the temperature up to the proper point until it is delivered into the cans. Under these conditions the work can be done without being pushed to the limit and a higher and more uniform temperature results in the mixture. The longer cooking reduces the foaming, so that the cans may be filled full between 190° and 200° F., or from 10 to 12 degrees higher than when dependence is placed upon the preheater alone. The preheater depends for heat upon open steam pipes, and is provided with a mixing device. A temperature regulator is needed at this point to assure uniformity and the best results.

The first patent granted for a corn-mixing device and a preheater was issued to Merrill and Soule, of Syracuse, New York, in 1874, and the apparatus, with minor modifications, is still in use.

Controlling the Consistency of Batches

The matter of controlling the consistency of batches has been studied by Charles J. Meister, of Fairmont, Minnesota, who has developed a device which he claims is a distinct assistance for this purpose. It consists of a funnel to hold a definite volume having a shape and an opening which have been determined by experiment to allow the contents to pass freely or to be retarded according to the fluidity or lack of that property. If the corn runs through quickly, it is sloppy; if very slowly, it is heavy; the limits of time below or above that which is satisfactory being easily determined. The test has the advantage of being simple and quickly made. The apparatus is described as follows: "To obtain the desired results a funnel-like appara-
tus has been designed and used successfully for several years at the Fairmont plants. The apparatus, which is now being placed on the market, consists of a funnel of cast aluminum, 10\(\frac{1}{2}\) inches high and 5\(\frac{1}{2}\) inches in diameter, having a cast aluminum cap machined to fit over the lower end. It stands on a tripod 17 inches high over a tall copper can 9 inches high and 3\(\frac{1}{2}\) inches in diameter, with a copper handle attached.

In addition to the apparatus, a stop watch is used for making all tests. Different kinds of apparatus other than funnels, and also funnels of different shapes and sizes were tried before this was finally adopted. No doubt other shapes or sizes of funnels might be used for this purpose, but this would necessitate that another design be tested over a period of years, as this has been, before it would be possible to say definitely that it met all requirements. This apparatus does not give satisfactory data on detailed viscosity tests, but probably could be improved if more delicate tests were necessary. However, it controls a pack of corn so that slight variation in the funnel test cannot be detected by the spoon test, which is the final consistency test for canned corn. The general procedure is as follows:

After the cut silked corn has been placed in the mixing tank, an estimated number of gallons of brine are metered into the tank. The batch is now heated to the temperature for filling into the cans. This temperature is usually about 190° F. A sample of 40 ounces is now drawn from the bottom of the tank and poured into the funnel with the bottom cap in place. As the cap is removed, a stop watch is started and the watch stopped just at the time the last of the 40 ounces of corn runs out of the funnel. This is noted accurately by looking down into the top of the funnel and stopping the watch just as one is able to see through the opening at the bottom.

Temperature plays an important part in a test of this kind, as the sample taken from the bottom of the mixing tank must not be allowed to cool. In order to prevent the funnel from taking up part of the heat from the sample, it is allowed to stand in a small tank of water at 190°, so that it has the same temperature as the samples of corn. If it takes too long for the sample of corn to run through the funnel, one or two gallons of brine should be added and the test repeated. If it runs through too rapidly, more corn must be added and the test repeated until the right number of seconds is indicated.

After the first few batches have been run a close estimate can usually be made as to the number of gallons of brine to be added to each batch of corn. Of course, a definite quantity of corn is always taken for each batch and the brine is metered into the corn so that a definite record can be kept on each batch mixed. The operator of the funnel as he tests each batch of corn can tell usually whether the batches are tending to get thicker or thinner as they are tested, and by changing the volume of brine as he notices this change taking place, it is seldom necessary to make more than one test on each batch. However, it takes such a short time to make the test on each batch that several tests could be run without causing any delay at the filler.

Great care should be exercised at all times to see that the temperature of the batch remains the same and that the temperatures of all batches are the same.
It has been noted by testing the first and last of a batch that there is sometimes a greater variation in the corn at the start of the run on a batch than at the end. This is caused by insufficient agitation or by the agitator moving slower than it should. If heated to the proper temperature and agitated properly, the test at the beginning and at the end of the batch will be the same. If the batch be heated to about 200° F. or above, it will foam somewhat, and the end of the batch be very thin. Should a batch be mixed and not heated above 170° F., the starch will not flow properly and when the sample is poured into the funnel, the kernels will sink to the bottom and plug the opening so the test cannot be run. It is very unusual to have a batch mixed at a low temperature, but if this should happen, it gives a very uneven consistency to the finished product, and is detrimental to quality.

"The average test for the different varieties is given here for an average season with corn of a proper maturity as follows: 40 ounces Crosby corn at 190° in the mixing tank should run through the funnel in ten seconds. Nine seconds would be a minimum and would be satisfactory for mature corn. If very mature, eight seconds might be specified. Eleven seconds would be the maximum, and would be desirable for corn a little immature. With Country Gentleman or Golden Bantam, eleven seconds is right, and ten seconds would be permissible if a trifle mature. If a little immature, twelve seconds should be obtained. These specifications will give a little heavier consistency for the Country Gentleman than for the Crosby, which we believe, conforms to the ideas of the better class of trade."*

Cooking

From the beginning, corn proved to be a most refractory substance to sterilize. According to the evidence, Winslow lost most of his experimental lots. He and other early packers cooked at boiling for one and one-half hours, then vented and returned the cans to the bath for an additional two and one-half hours. Some of it kept, and from what is known concerning the methods used one may infer that it was of the whole grain type or rather thinly packed. Prescott and Underwood† in their first paper upon "Sour Corn" presented at the canners’ convention in 1898, state that in a Massachusetts factory the process on corn had been five hours at boiling temperatures for twenty years but that losses occurred in 1878, so the process could not be used after that though a number of trials were made, as it was felt that the corn cooked at this temperature had a better flavor than that which was cooked at higher temperatures. Solomon introduced calcium chloride into the process baths in this country in 1850, but it is not known how rapidly it was adopted by corn packers, but seems to have become common by 1875. The retort came into use in 1873, and was immediately adopted so that after 1875 the water-bath was discarded and was rapidly replaced by these two high temperature cookers. The cook used in the period which followed was based wholly upon experience, and while the results were better because of the higher temperatures used, they were far from being under control or satisfactory. It was not until 1896 that Prescott and Underwood determined the cause of spoilage in corn to be

due to bacteria and gave a rational explanation of what was required in cooking to insure sterility. This work and that which they did in the next few years is basic and of the highest importance, not only to corn packers but also to the entire canning industry, but has not been appropriately recognized nor appreciated. They determined the kinds of organisms present in corn, the source from which they were derived, the temperature necessary for their destruction, and the time required for the heat at the temperature of the retort to penetrate to the center of the can. They pointed out that corn is a particularly poor conductor of heat, and that in a given process of 246° F. for one hour the center of the can was subjected to that temperature for only five minutes and recommended that under the conditions used in their experiments (in factory operation) that the process be 250° for 60 minutes. With these data and their methods of experimenting as a starting point, it was easy for other investigators to follow and make additions, and for intelligent processors to conduct their work with safety. In 1905, Duckwall made the following recommendation as a result of wide experience in factory investigations: “As a general proposition, then, we can say that 250° for sixty-five minutes is a safe process for corn if it is not too dry. There must be enough fluid to carry the temperature from the parts nearest the tin to the center. If there is not enough fluid to do this, an impenetrable wall will form within the can, and the spores (in the center of the can) will not be subject to the temperature which registers on the retort, and consequently may live through any process.”

In 1907, the writer, while in the Government service, determined the rate of heat penetration as affected by the consistency and thus cleared up what was then an unknown factor in spoilage. Prescott used the first maximum recording thermometer for getting the highest temperature attained at the center of the can, and the writer the first thermometer inserted through the can, also an electrical recording device to obtain the temperature at any moment in the can while it was in the bath or retort.

As a result of the work which had been done up to that time (1907), the process for a No. 2 can, allowing for the varying consistencies used in canning, was determined to be from 245° to 250° F. for 75 minutes, provided the corn was in good condition and handled with reasonable speed. Five to ten minutes additional was recommended for corn which remained in piles over night. No material change has since been recommended which adds to the safety of the cook. With better control of the consistency and a better understanding of the importance of the initial temperature, it is probable that the temperature may be reduced or the time shortened, particularly for that rated as of light or medium body.

It is one of the peculiar incidents in the industry that the study of agitation as affecting sterilization in vegetables, now so generally used in canning, was first carried out on corn but has had little use in cooking cream style corn. It has been found that a temperature of 250° F. for 45 minutes in a continuous agitating cooker is ample for sterilization. The cans are carried on the cooker reel but not made to rotate on their own axis as by this procedure curdling is prevented.

A recent patent No. 1,884,300, October 25, 1932, issued to Ogden S. Sells, contains the following:

A can of corn freshly opened, to be of the highest visual quality, should present a light creamy color. All canners strive to get and maintain this color in their pack.
If the freshly opened can presents a brownish tinge or any shade darker than a light cream color it may not pass for the highest visual quality if there happens to be corn of a lighter color at hand with which to compare it.

I have discovered through exhaustive experiments that if corn is processed in a receding temperature that the much desired creamy color is produced throughout the can during the processing; the containers are subjected to less strain from internal pressures; the seams are less expanded and a general all around better processing and sterilization is obtained.

My improved method differs from all of the usual processing practices in that I start the processing at a higher temperature than is standard practice and end the processing at a much lower temperature than it was started at and find I get a proper sterilization with less time.

My starting temperature is around 260° F. instead of the regular 250° F. and my ending temperature is around 212° F. to 225° F.

In between these two temperatures I may regulate the scale as may be necessary or desirable to produce any certain results in the finished pack. I may maintain the 260° F. temperature for a matter of 30 minutes and then reduce it to around 212° F. or 220° F. for another 25 minutes, thus getting proper sterilization in 55 minutes as against 70 minutes for the regular practice and producing a beautifully colored product that needs no after manipulation to distribute the varying colors of the pack due to the ordinary high temperatures and longer time.

Cooling

Cooling is essential to get a bright even product and also as an insurance against flat sours. The cooling should preferably start in the retort under pressure with the water admitted from the bottom and the overflow at the top, rather than by spraying from above. The strains on cans which cause leaks and buckles are distinctly less than when the water strikes the top and causes a sudden contraction of the gas in the headspace. Neither the time required nor the amount of water needed are greater than when top flooding is used. In the case of the closed retort, compressed air should be admitted in advance of the water so that a vacuum will not be formed in the retort due to sudden condensing of the steam by the inrush of water, and the pressure maintained until the cans are flooded. Whether the cooling be complete in the retort or only partial may be made to depend upon the water supply available and the rate at which the retorts are needed. In most corn packing establishments the use of a separate cooling tank is a necessity and all the cooling is done in the tank. The crates of cans are conveyed through it mechanically and thereafter to the ware room. If the tank be short, the cooling may be very imperfect. Corn gives up its heat very slowly so that the cans may feel cool to the touch and yet be well above a hundred degrees in the center. The cooling is irregular for the cans are stacked as closely as possible in the three or four tiers in the crates and thus the innermost cans are protected by those on the outside. An open agitating cooler such as used for fruits could undoubtedly be used to great advantage, for in this style each can becomes the unit and the treatment is uniform. The rotation of the contents insures that the maximum of heat is given off.

Placing the cans in cases or stacking them in the warehouse before they are cold is a dangerous procedure.

Packing No. 10 Cans

The packing of No. 10 cans for hotel and restaurant trade has been tried many times but without a very high degree of success until recently. The trouble is due to two causes: the first is very slow heat penetration coupled
with insufficient time, and the other the number of cans damaged by the severe process. George Grebe, of Showano, Wisconsin, seems to have solved the problem in a practical way, pointing out that it is necessary to precook well to get all the foam out of the corn, to fill the can full at 200°, and to process for four hours at 250°. A record of the temperature within the cans shows that the start in the retort is made at 198°, that it requires two hours and thirty-five minutes to reach 240°, three hours and forty-five minutes to reach 250°, and that this is maintained for twelve minutes before starting to cool under pressure. The process found necessary to secure heat penetration in the factory is decidedly heavier than that indicated when based upon mathematical calculations.

U. S. Standards

UNITED STATES STANDARDS FOR GRADES OF CANNED CORN—CREAM STYLE
(Approved November 22, 1932)

DEFINITION
Canned corn is the canned vegetable prepared from the immature grain of sweet corn (Zea mays L.) with or without the addition of salt and/or sugar, with the addition of such quantities of potable water as may be necessary in the proper preparation of the product, packed in hermetically sealed containers, and sterilized by heat.

STYLES OF CANNED CORN

CREAM-STYLE canned corn is canned sweet corn prepared from corn removed from the cob by shallow cutting through the grain and subsequent scraping, causing it to have a creamy consistency.

WHOLE-GRAIN STYLE canned corn is canned sweet corn prepared from corn removed from the cob by cutting in such a manner as to leave the grain substantially whole. The grains are surrounded by brine, except when “vacuum packed.”

GRADES OF CREAM-STYLE CANNED CORN

U. S. Grade A (fancy) canned corn is the product prepared from young, tender sweet corn which possesses similar varietal characteristics. The color of the product is bright and the product possesses a heavy creamlike consistency. It is practically free from defects such as silks, husks, particles of cob, off-colored kernels, etc. The kernels have been neatly and uniformly severed from the cob and are of such a degree of maturity that they are very tender and are in the early cream stage. The product possesses a flavor typical of succulent young corn, and scores not less than 90 points when scored according to the scoring system outlined herein.

U. S. Grade B (extra standard or choice) canned corn is the product prepared from tender sweet corn which possesses similar varietal characteristics. The color of the product is reasonably bright and the product possesses a creamlike consistency. It is reasonably free from defects such as silks, husks, particles of cob, off-colored kernels, etc. The kernels have been severed at a reasonably uniform distance from the cob and are of such a degree of maturity that they are tender and in the cream stage. The product possesses a good flavor, and scores not less than 75 points and need not score more than 89 points when scored according to the scoring system outlined herein.

U. S. Grade C (standard) canned corn is the product prepared from reasonably tender sweet corn which possesses similar varietal characteristics. The color may be dull and the product may possess a consistency showing a slight separation of free liquor, or contrariwise, an insufficiency of moisture. The product is fairly free from defects such as silks, husks, particles of cob, off-colored kernels, etc. The kernels may be lacking somewhat in uniformity of size and they are of such a degree of maturity that they may be in, but have not passed, the dough stage. The product possesses a palatable flavor, and scores not less than 75 points and need not score more than 74 points when scored according to the scoring system outlined herein.

Off-Grade (substandard) canned corn is canned sweet corn which scores less than 60 points when scored according to the scoring system outlined herein, or, when any one of the grading factors, with the exception of cut, falls in the subdivision D.
PREREQUISITES TO GRADING

Condition of Container

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents, and the ends shall be flat or concave.

Condition of Package and Label

If cased, the canned corn shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Federal food and drugs act.

Fill of Container

Cans of corn will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container, and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned corn that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

A certificate of grade covering canned corn that does not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,

"Below U. S. Standard—Slack Fill"
"Contains Excess Added Liquid"

The maximum head space allowable in the sizes commonly used in packing cream-style corn is shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum head space allowable (measured from top of double seam in sixteenths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 (picnic)</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 2</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 2½</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 10</td>
<td>13.6</td>
</tr>
</tbody>
</table>

ASCERTAINING THE GRADE

The grades of cream-style canned corn may be ascertained by considering the following factors: Color, consistency, absence of defects, cut, maturity, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits which may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color</td>
</tr>
<tr>
<td>II. Consistency</td>
</tr>
<tr>
<td>III. Absence of defects</td>
</tr>
<tr>
<td>IV. Cut</td>
</tr>
<tr>
<td>V. Maturity</td>
</tr>
<tr>
<td>VI. Flavor</td>
</tr>
</tbody>
</table>

Total: 100

Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means 12, 13, and 14.

I. Color

(A) To receive the full credit of 5 points for color, canned corn must be bright and true to the color of the type or variety claimed for the corn.

(B) If a slight deviation from the natural color is found, a credit of 4 points may be allowed.
(C) Corn that is dull or of poor color may receive not to exceed 3 points credit. Corn of poor color, or that falls in this classification, shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) Corn having a decidedly "off" color or distinctly bad color, regardless of the reason for the inferiority, may not be scored more than 2 points.

II. Consistency.—The term consistency has reference to the density and viscosity of the product.

(A) To receive a rating within the highest group, 22 to 25 points, for this factor, the product must have a heavy creamlike consistency. Corn of this consistency when poured into a grading tray will mound to some extent.

(B) If the corn may be said to have a good creamy consistency—that is, when emptied from the can, if it flows just enough to level itself readily—a credit of 19 to 21 points may be allowed.

(C) If the product shows a slight separation of free liquor, or on the other hand, when it is deficient in moisture to the extent that the product when poured from the can possesses a semi-liquid or jellified form, a credit of 16 to 18 points may be allowed.

(D) Credit ranging from 0 to 15 points is permissible when the product is thin and watery, or contrariwise, extremely dry, pasty, or crumbly.

III. Absence of Defects.—The factor relating to defects deals principally with workmanship, having reference to the degree of freedom from objectionable substances such as silks, husks, particles of cob, hard kernels, worm-eaten kernels, can black, discolored kernels, and rust. The presence of "pulled kernels"—that is, kernels that have not been severed from the cob by cutting—is to be taken into consideration.

(A) The highest rating, 19 to 20 points, for this factor, may be given only when the corn is practically free from such defects.

(B) If but an occasional defect is detected, 16 to 18 points may be allowed.

(C) If the defects are not of sufficient importance to detract from the appearance of the product or materially lessen its edible value, 13 to 15 points may be allowed.

(D) When the defects are prominent, a credit of 0 to 12 points may be allowed.

IV. Cut.—The factor of cut relates to the character of cut; that is, the effect of the cut on the appearance of the product.

(A) If the corn appears to have been evenly severed from the cob (close to the cob but including none of the cob tissues), a credit of 5 points may be allowed.

(B) If the cut is lacking somewhat in the above uniformity, a credit of 3 to 4 points may be allowed.

(C) If the cut is poor, having an irregular or ragged effect, only 1 to 2 points shall be allowed.

(D) If the cut is very irregular, no credit is allowable.

V. Maturity.—Credits for the factor of maturity shall be based on the degree of tenderness or the starchiness of the corn.

(A) To receive a rating within the highest group, 22 to 25 points, the kernels must be well developed but very tender, in what may be termed the early cream stage, but not so young that the product possesses a somewhat curdled appearance.

(B) Tender corn in the cream stage may be credited within the range of 19 to 21 points.

(C) If the kernels of corn are firm and are entering or in, but have not passed, the dough stage, a credit of 16 to 18 points may be allowed. Corn scoring in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) Corn that is tough and past the dough stage, or that is so young that the product possesses a curdled appearance, may be given from 0 to 15 points for this factor.
VI. FLAVOR.—The quality of flavor of canned corn shall be classified from the standpoint of palatability. The natural flavor of the corn is to be given primary consideration, regardless of the addition of, or absence of, sugar and/or salt, except as provided in paragraph D below.

(A) Corn that has a typical, distinctly young, tender, corn flavor is entitled to the highest rating, 17 to 20 points, for this factor.

(B) Corn that has a good flavor, but with the young corn flavor not so distinct, may be given a rating within the range of 14 to 16 points.

(C) If the flavor is considered fair, but palatable, or possesses, for instance, a somewhat matured mealy taste, only 11 to 13 points may be allowed.

(D) If the flavor is decidedly poor, musty, or scorched, or if the product has been excessively salted or sweetened, from 0 to 10 points may be allowed.

Whole Grain or Maryland Style Corn

Whole grain corn, as its name indicates, differs from the cream style in that the kernels are cut to retain as many whole or nearly whole as may be possible, the smaller bits are screened out and no pulp added. Since 1927, this style of packing has been taken up in all the corn packing sections. This has been brought about by improved machinery for doing the work and from a better understanding of the difference in the quality of the raw stock necessary for this style of packing.

The raw stock used for whole grain corn must be slightly less mature than for the cream style and must also be more uniform in quality. This makes it next to impossible to strip a field at one picking and thus increases the cost of gathering. The yield is slightly less per acre than for the cream style but upon this point there are little data.

C. B. Sayer of the New York Experiment Station gives a comparison of the yield of corn when harvested for the two styles of packing. His table is small, but tells the story very clearly.*

**COMPARISON OF YIELDS AND RETURNS, WHOLE KERNEL VS. CREAM STYLE CORN**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Golden Bantam</th>
<th>Golden Bantam</th>
<th>Golden Bantam</th>
<th>Golden Evergreen</th>
<th>Golden Evergreen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest date</td>
<td>8/19</td>
<td>8/23</td>
<td>9/13</td>
<td>9/10</td>
<td>9/15</td>
</tr>
<tr>
<td>Size of plat, acres</td>
<td>1.0</td>
<td>0.19</td>
<td>0.19</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Style of pack</td>
<td>Whole</td>
<td>Cream</td>
<td>Whole</td>
<td>Cream</td>
<td>Whole</td>
</tr>
<tr>
<td>Pound unhusked corn</td>
<td>3767</td>
<td>4750</td>
<td>1540</td>
<td>1525</td>
<td>2570</td>
</tr>
<tr>
<td>Pounds husked corn</td>
<td>2562</td>
<td>3116</td>
<td>985</td>
<td>877</td>
<td>1332</td>
</tr>
<tr>
<td>Pounds selected corn</td>
<td>1521</td>
<td>312</td>
<td>951</td>
<td>1377</td>
<td></td>
</tr>
</tbody>
</table>

As the result of his work, Sayer made two suggestions: one that the seed corn be screened for size and that the large and small grains be planted in different plots so as to contribute to greater uniformity in field development, and the other to harvest all when in a prime state of development and sort into two grades, one for whole grain and the other for cream style. If the sorting be carefully done, both may be of fancy quality.

The factory operations differ after the corn is run through the husker and sorted. First, the ears are washed under very strong sprays of water, 70 pounds pressure or more, to remove the silk which remains between the rows. The ears are then conveyed directly to the cutter or they may be carried on a draper belt through a blancher, and cooled before going to the cutter. Blanching before cutting is done by about 40 per cent of the packers of this style of corn. There is a divided opinion upon its merits.

It is contended by some that by heating the corn while on the ear that the juices and starches are coagulated and therefore a less loss of juice and flavor from cutting while others contend that such a step tends to toughen the hull. As is usual in such cases most of the theories have been formulated without regard to the botanical structure of the kernel.

Mr. Englis and his associates* made some experiments to determine the effect of blanching which may be summarized as follows:

They found that using a blanching temperature of 180° to boiling and for varying periods between 3 and 6 minutes that there was so little difference in the results that one could not be distinguished from another with certainty. Puncture tests were used upon a large number of kernels, and it was found that the hull upon the blanched corn was punctured easily and not made tougher.

It was found after cooking both blanched and unblanched corn in the retort that the puncture test was reduced but that there was no appreciable difference due to blanching.

The studies also included the loss from washing corn which had been blanched by comparison with unblanched. The results show that in both cases the losses were directly proportional to the area of the cut surface. The losses in the blanched were from 67 to 96 per cent of the unblanched, but as the time of washing in the experiment was from 3 to 10 minutes or from 30 to 100 times as long as in factory operations, they do not properly reflect the actual losses.

D. T. Englis and C. D. Zannis† also made a report upon the effect of the depth of cutting of the kernel as affecting quality. The experiment was too small to be more than indicative of what may be expected. In a shallow cut there was more fiber and starch and less moisture than in a deep second cut. In the latter the sugars were decidedly higher.

Special cutters have been developed to the point where they will handle kernels of the flat type nearly as well as long slender grains. They cut close to the cob without inflicting much damage to the adjoining rows. The work is superior to hand-cutting, more uniform, and the waste materially less.

The corn is cleaned by gently shaking the kernels apart and running them over a screen to remove the coarse material while at the same time the grains are subjected to a blast of air to get rid of bits of silk, chaff, etc. The corn is again washed and run into the filler. In one of the late types of cleaners, the corn is dropped into a tank of water, in which the whole grains sink to the bottom and are removed by a conveyor while the light portion is floated off the top. The water is admitted from below in order to produce a moderate upward current.

†“The Canner,” June 25, 1932.
The fill of corn in the No. 2 can is from 13.5 to 14 ounces, and the brine contains from 1.5 to 2 per cent of salt and a slightly greater amount of sugar. The sugar content is held low in order to balance the added dilution made by the brine and thus retain the maximum corn flavor.

The increase in weight on the cut-out is from .5 to 1.5 ounces on young corn, and may be as high as 2.5 to 3 ounces for more mature corn. The cut-out should average slightly over 14 ounces, the minimum permitted being 13.5 ounces.

The filled cans are run through an exhaust box, sealed, and cooked in the usual manner. Sterilization is easy by comparison with cream style corn, due to the ease of heat penetration. The cook most often used is 248° F. for 40 minutes, which may be cut to 30 minutes in an agitating cooker.

U. S. Standards

UNITED STATES STANDARDS FOR GRADES OF CANNED CORN—WHOLE-GRAIN STYLE
(Approved November 22, 1932)

DEFINITION

Canned corn is the canned vegetable prepared from the immature grain of sweet corn (Zea mays L.) with or without the addition of salt and/or sugar, with the addition of such quantities of potable water as may be necessary in the proper preparation of the product, packed in hermetically sealed containers, and sterilized by heat.

STYLES OF CANNED CORN

Whole-Grain Style canned corn is canned sweet corn prepared from corn removed from the cob by cutting in such a manner as to leave the grain substantially whole. The grains are surrounded by brine, except when "vacuum packed."

Cream-Style canned corn is canned corn prepared from corn removed from the cob by shallow cutting through the grain and subsequent scraping, causing it to have a creamy consistency.

GRADES OF WHOLE-GRAIN STYLE CANNED CORN

U. S. Grade A (fancy) canned corn is the product prepared from young, tender, sweet corn. The product is practically free from defects such as silks, husks, particles of cob, off-colored and/or damaged grains; possesses the distinct flavor of succulent young corn; and scores not less than 90 points when scored according to the scoring system outlined herein.

U. S. Grade B (extra standard or choice) canned corn is the product prepared from substantially whole grains of reasonably tender sweet corn, severed from the cob with reasonable uniformity. The grains are of a reasonably bright color. The product is reasonably free from defects such as silks, husks, particles of cob, off-colored and/or damaged grains; possesses a good flavor; and scores not less than 75 points and need not score more than 89 points when scored according to the scoring system outlined herein.

U. S. Grade C (standard) canned corn is the product prepared from substantially whole grains of sweet corn that may be entering or in, but has not passed, the dough stage, and the cut of which grains may lack uniformity. The grains may be slightly dull in color. The product is fairly free from defects such as silks, husks, particles of cob, off-colored and/or damaged grains; possesses a palatable corn flavor; and scores not less than 60 points and need not score more than 74 points when scored according to the scoring system outlined herein.

Off-Grade (substandard) canned corn is canned sweet corn which scores less than 60 points when scored according to the scoring system outlined herein, or when any one of the grading factors, with the exception of cut, falls in the subdivision D.
PREREQUISITES TO GRADING

Condition of Container
Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents, and the ends shall be flat or concave.

Condition of Package and Label
If cased, the canned corn shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Federal food and drugs act.

Fill of Container
Cans of corn will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality. No head space is deemed excessive, however, unless it exceeds one-fourth inch. In vacuum-packed products the head space is determined after pouring out the contents, breaking up lumps if necessary, returning them to the original container, and leveling without agitation or without downward pressure.

A certificate of grade covering canned corn that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

A certificate of grade covering canned corn that does not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,

"Below U. S. Standard—Slack Fill"
"Contains Excess Added Liquid"

The maximum head space and the minimum drained net weight allowable in the sizes commonly used in packing whole-grain corn is shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can size</th>
<th>Minimum drained weight required (in ounces)</th>
<th>Maximum head space allowable (measured from top of double seam in sixteenths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 (picnic)</td>
<td>7.25</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 2</td>
<td>13.50</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 10</td>
<td>72.00</td>
<td>13.6</td>
</tr>
</tbody>
</table>

ASCERTAINING THE GRADE

The grades of whole-grain style canned corn may be ascertained by considering the following factors: Color, absence of defects, cut, maturity, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits which may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color ............................... 10</td>
</tr>
<tr>
<td>II. Absence of defects ................ 20</td>
</tr>
<tr>
<td>III. Cut ......................... 10</td>
</tr>
<tr>
<td>IV. Maturity ..................... 35</td>
</tr>
<tr>
<td>V. Flavor ..................... 25</td>
</tr>
</tbody>
</table>

Total........................................... 100

Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means 12, 13, and 14.

1. Color.
(A) To receive a rating within the highest group, 9 to 10 points, for this factor, the product must be uniformly of a good bright color, natural to the variety.
(B) If a slight deviation from the natural color is found, a credit of 7 to 8 points may be allowed.
(C) If the product is dull in color, or in white varieties has a brownish cast, a credit of 5 to 6 points may be given. Corn that falls in this classification shall not be graded above U. S. Grade C, or Standard, regardless of the total score for the product.
(D) Corn having an "off" color or distinctly bad color, regardless of the reason for the inferiority, may not be scored more than 4 points for this factor.

II. ABSENCE OF DEFECTS.—The factor relating to defects deals principally with workmanship, having reference to the degree of freedom from objectionable substances such as silks, husks, particles of cob, off-colored and/or damaged grains, clusters of grains, hard or worm-eaten grains, can black, and rust.
(A) The highest rating, 19 to 20 points, for this factor, may be given only when the corn is practically free from such defects.
(B) If but an occasional defect is detected, 16 to 18 points may be allowed.
(C) If the defects are not of sufficient importance to detract from the appearance of the product or materially lessen its edible value, 13 to 15 points may be allowed.
(D) When the defects are prominent, a credit of 0 to 12 points may be allowed for this factor.

III. CUT.—The factor of cut relates to the character of cut; that is, the effect of the cut on the appearance of the product.
(A) If the corn has been evenly severed from the cob (close to the cob but including none of the cob tissues), a credit of 9 to 10 points may be allowed.
(B) If the cut is lacking somewhat in the above uniformity, 7 to 8 points may be allowed.
(C) If the cut is irregular and lacking in uniformity, 5 to 6 points are allowable.
(D) If the cut is very irregular, a score of only 0 to 4 points may be allowed.

IV. MATURITY.—Credits for the factor of maturity shall be based on the degree of tenderness or the starchiness of the corn.
(A) To receive a rating within the highest group, 31 to 35 points, for this factor, the grains must be well developed but very tender, in what may be termed the milk stage.
(B) Tender corn in the cream stage may be scored within the range of 26 to 30 points.
(C) If the grains of corn are firm, or are entering the dough stage, a credit of 21 to 25 points may be allowed. Corn that falls in this classification shall not be graded above U. S. Grade C, or Standard, regardless of the total score for the product.
(D) Corn that is tough or "leathery" and past the dough stage, or that is so young that the grains are undeveloped, may be given from 0 to 20 points, for this factor.

V. FLAVOR.—The quality of flavor of canned corn shall be classified from the standpoint of palatability. The natural flavor of the corn is to be considered, regardless of the addition of, or absence of, sugar and/or salt.
(A) Corn that has a typical, distinctly young, tender corn flavor is entitled to the highest rating, 22 to 25 points, for this factor.
(B) Corn that has a good flavor, but with the young corn flavor not so distinct, may be given a rating within the range of 19 to 21 points.
(C) If the flavor is considered fair, but palatable, or possesses, for instance, a somewhat matured taste, only 16 to 18 points may be allowed.
(D) If the flavor is poor, or decidedly objectionable, or if the product has been excessively salted or sweetened, 0 to 15 points may be allowed.

Patented Process
Patent No. 1,742,240, January 7, 1930, issued to Maurice V. Douthitt, provides a variation in the preparation of corn for canning.
My invention provides an improved method or process of preparing and canning corn, especially of the whole or full cut type, whereby the natural color and flavor of the corn are maintained and a superior quality of canned corn is produced. The manner in which this improved process has, in practice, been carried out, is as follows:
1. The unhusked ears of corn are placed in boiling water or subjected to steam, either of which actions is herein treated as the equivalent of subjecting the same to a boiling or initial cooking action, and by this first step, the corn is initially or at least partially cooked, not only while it is on the cob, but while it is surrounded by and subject to the juices from the husks. Thus, all of the original juices, starch and sugar are at least partly set within the kernels of corn.

2. The corn ears, with the husks still on, are then placed in or subjected to a vat or spray of cold water, which chills or permanently sets the starches and sugars in the corn kernels.

3. The husks are then removed from the ears, either by hand or by suitable machinery.

4. The corn will next be cut from the cob, either by hand or machinery.

5. The cut corn is then subjected to separating means, such as a shaking screen, the meshes of which will allow the whole kernels of corn to pass therethrough and will not pass therethrough but will carry off the pieces of cob, corn silk and any husks not before removed.

6. The corn, which is then quite cleaned but may contain some particles of corn silk or other light objects, is then put through a flotation process by emersing the corn in water and floating off the light particles.

7. The cans are then filled with the cut corn and the proper amount of syrup is added to give the same the desired sweetness, and the filled cans are subjected to a cooking heat varying from 160° to 200° Fahrenheit, and the cans are then sealed.

8. To complete the cooking of the corn, it is customary to place the closed cans in retorts and to subject the same to cooking heat.

The vital difference between this improved method and the older methods or processes is in the manner and order in which the steps 1 to 4, inclusive, are carried out. Usually, the husks are removed from the corn before the initial cooking of the corn is performed and, by this older method, much of the natural flavor of the corn is lost and the color of the corn is changed, but by the improved process above described, substantially all of the natural flavor and the color of the corn are maintained.

The initial cooking with the husks on the cobs has a bleaching effect, which prevents discoloration of the corn, that is, offsets that effect of cooking which tends to darken the corn. The first step above described facilitates the rapidity of the process because it permits the unhusked corn to be dumped directly from wagons into the boiling water or steam receptacle.

**Hulled Corn**

Hulled corn is also produced by a patented process but now open by reason of expiration of the time limit. The ends of the grains are slit while attached to the cob and then the contents squeezed or scraped out by means of blunt scrapers in the same manner as the pulp is removed in cut corn in the cream style of packing. The regular corn cutting machine is used, but slitting knives take the place of the regular cutter blades. The product is like green corn-meal mush. The claim is made that all the nutritive material is conserved without the indigestible hulls. This style of packing was given considerable publicity at one time, but its use never attained a large volume.

Another style of hulless corn was developed in 1890, known as “kornlet,” produced by running the regular cut corn through a cyclone with a screen having special openings that served to remove the hull. The cooking of hulless corn is the same as for the cream style.

**Corn on the Cob**

Corn on the cob has been an objective with many canners but production has never attained any considerable volume. The flavor is not equal to the cut corn and few ears can be packed in a can. The larger portion of that which is packed is put up in No. 10 cans for hotel and restaurant trade.
Since Golden Bantam corn has found favor for canning, that variety is preferred as the ears are so small that even No. 2 cans may be used. The flavor is also superior to other varieties for this purpose. The ears are trimmed to the exact length of the can, precooked for ten minutes, placed in the can as quickly as possible, covered with hot brine, and cooked at 230° F. for from 90 to 100 minutes. The time allowed for bringing up the temperature and for cooling is longer than for the regular pack, or about 15 minutes.

Succotash

A popular combination with corn is lima beans, either green or dry, known by the Indian name, succotash. This term was originally applied to a combination made of dried green corn and ripe beans, and by extension the name has been given to the canned combination of the green corn and green beans. In canned succotash the corn is prepared in the cream style and the beans added in the proportion of not less than 20 per cent during the mixing of the batch. As the corn and beans do not mature at the same time in some places, soaked lima beans may be used but that fact must be declared upon the label. The green beans are shelled in a pea viner having proper cylinder screens and may be graded for size or be the run of the pod. It is usual to use small beans in the fancy grade of succotash and ungraded beans in the standard grade. The cooking is the same as for cream style of corn, also the same can sizes are used.

Corn and Tomato

A mixture of corn and tomatoes is packed more especially to meet a demand for such a mixture in the South. The whole grain style of cutting is used but there is no definite proportion of corn and tomato required. Sterilization is easy, being the same as for whole grain corn.

Corn is also added to many vegetable soups, in which event shoepeg or other narrow grain variety is selected and recut to obtain short bits.

Label Weights

Cream style and whole grain (Sp. Gr. 1.03) : 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs. Vacuum pack: No. 2 Squat, 10 ozs.

Corn on the cob (Sp. Gr. 1.05) : No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

Succotash (Sp. Gr. 1.08) : 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

S. R. A. No. 4. The Addition of Cornstarch to Canned Corn.

The Board has been advised that the following situation confronts the canners of corn in certain sections of the country.

The corn has ripened very late, and, in spite of the fact that the corn is of the finest quality and flavor, it lacks sufficient starch to pack properly on account of the fact that the liquids will separate from the solids in the canning, and, therefore, in order
to produce a satisfactory product it is necessary to add cornstarch to the extent of \(1\) to \(1\frac{1}{2}\) per cent.

In the opinion of the Board, on the facts as stated, and, if no inferiority of the corn is concealed, this addition would be permitted, under regulation 25, section 7, (a) which states that “When a substance of a recognized quality commonly used in the preparation of a food or drug product is replaced by another substance not injurious or deleterious to health, the name of the substituting substance shall appear upon the label.” If a product, prepared as indicated, were plainly labeled “Sweet Corn with added Starch,” there would not appear to be any violation of the Food and Drugs Act.

It is, however, plain to the Board that starch may be added to sweet corn in a manner whereby inferiority is concealed, and whereby water is added, which addition of starch would clearly constitute a violation of the act. The canners are, however, familiar with the conditions under which they are working, and the Board is not; the canners should, therefore, be able to decide the proper course from the above statements of facts.

S. R. A. 69. Use of the Terms “Sugar Peas,” “Sugar Corn,” and “Champion Peas.”

Reference is made to your inquiry regarding the use of the terms “sugar peas,” “sugar corn,” and “champion peas.”

This matter has been discussed with the Bureau of Plant Industry, and as a result of the statements made by that Bureau, you are informed that the use of the terms “sugar corn” and “sugar peas,” as applied to varieties which are distinctly sweet is not regarded as objectionable. The terms “sweet corn” and “sugar corn” are used interchangeably, and the term “sugar peas” is used also for some of the higher grades of wrinkled peas which are used in canning. The term “sweet peas” would not be regarded as a synonym for “sugar peas,” since the former term is confined exclusively in horticultural literature to the types of peas grown for their flowers. Sugar is customarily used in connection with the canning of both corn and peas for the purpose of sweetening the liquor, and it should be understood that the use of sugar in canning corn or peas does not justify the use of the terms “sweet corn,” “sugar corn,” and “sugar peas” for such products. As stated above, the use of these terms is only proper when the varieties are distinctly sweet. In this connection, the provisions of Food Inspection Decision 66 should be borne in mind.

F. I. D. 71. Labeling of Succotash.

A manufacturer writes as follows:

We respectfully call your attention to the canned article known as succotash, which is composed of green sweet corn and lima beans. Both dried and green beans are used. The question to which we desire an answer is this: Is it sufficient to call the product “Succotash”? The word “succotash,” if used without qualification, is understood to imply that the product designated is composed of green sweet corn and green beans. If soaked beans or soaked corn (i.e., dried beans or corn softened in water) are employed, the name should be accompanied by declaration of that fact, such declaration to be in type not smaller than eight point (brevier) capitals.

S. R. A. 341. Weight of Maryland Style Corn in No. 2 Cans.

The Bureau recently has made an investigation to determine the amount of Maryland style or whole grain corn contained in No. 2 cans packed to capacity without impairment of quality.

It may be stated as a practical guide that well-filled cans should, after processing, have a head space (measured from the bottom of the cover to the surface of the liquid) not greater than one-quarter inch. The amount of liquid should be just sufficient to cover the corn. The sanitary cans a head space of one-quarter inch is practically equivalent to a distance of three-eighths inch, measured from the top of the rim of the can to the surface of the liquid, the can being cut from the top.

The average drained or “cut-out” weight for properly filled cans is about 14.5 ounces. In no case was a weight of less than 13.5 ounces found, which weight will therefore be regarded as a minimum. However, if the head space and appearance
show the can to be slack filled, the fill obviously will not be regarded as satisfactory, even though the minimum of 13.5 ounces has been attained. Fourteen and one-half (14.5) ounces will be regarded as an average standard. Due allowance will be made when smaller weights represent properly filled cans. In some instances cans filled to capacity without impairment of quality will be found to yield drained weights in excess of 15 ounces. All cans should be packed with the maximum amount of corn consistent with maintenance of quality, and the drained weights specified should be exceeded when possible without impairing quality.

The investigation has further shown that the “swell,” or increase from “put-in” to “cut-out” weight of corn, ranges ordinarily from 0.5 to 1.5 ounces for young corn and from 2 to 3 ounces (or even more in some instances) for old corn.

The drained weight is determined by draining the contents of the cans for two minutes on a one-eighth inch mesh screen.

In making declarations under the net weight requirement of the Federal food and drugs act, the total weight of the contents of the can, liquid included, should be declared.

**Difficulties**

The effect of the long high temperature cook upon the corn is to cause a darkening of color, the production of a stiffer body, and the development of a decidedly cooked taste and odor. The darkening in color and over-cooked taste are most pronounced in the portion next to the can wall, therefore it is usual to shake the cans well to distribute the contents uniformly and thus render the defects less apparent. These objectionable features become more pronounced as the temperature exceeds 240° F. so that some of the better packers do not permit the temperature to exceed 245° but extend the time to give an equivalent sterilizing effect. In the desire to accelerate operations, the general rule is to use the higher temperature. Another practice is to bring the temperature up rather slowly, using ten or eleven minutes, instead of pushing it at the highest possible speed. When the full head is turned on suddenly, there is a thickening of the mass next to the can wall which is little short of scorching, while if the heat be applied more slowly, the heat transmission becomes established in the mass and this condition is averted to some extent. With the agitating cooker the heat is applied to the full degree but the rotation of the can prevents the stiffening of the contact layer before the body behind it becomes heated. The effect of heat is always to deepen color and a moderate amount of yellowing is desired but a deep dull or brownish yellow is objectionable. Corn grown in some localities seems to be more sensitive to these color changes than that grown elsewhere.

**Black in Corn**

The presence of black specks, black flakes, dirty gray color due to black being mixed with the corn, and black spots or patches on the inside of the can in the headspace have been matters of complaint since corn has been packed. Sometimes the amount has been so small as to be recognized only by those who are familiar with the trouble, and again it is so heavy as to be discernible to the most careless purchaser. There are many who believe the trouble to be of recent origin and associated with the use of the open top can and to poor quality of tin-plate, but its history shows that it was well known prior to the advent of the open top can. As with many other things connected with canning, the exactions of the trade were less critical and defects were not so frankly discussed. No other single problem in the industry has received a like amount of attention from the canner, the can
maker, and the tin-plate manufacturer. It has been the object of almost continuous research since 1912. The nearest approach to the solution has been the introduction of a can coated on the inside with a special lacquer containing a minute quantity of zinc salts.

In cooking the corn in the cans, hydrogen sulphide is liberated in small quantities which combine with the iron of the can to form black sulphide of iron. No method of making base plate nor coating with tin has been devised which is so nearly perfect that the gas cannot come in contact with the iron at points from those of microscopic size to visible spots, cracks which the tin fails to coat or which in bending and forming the can loosen, or to the cut raw edges. No amount of precooking the corn liberates all this sulphur compound and in addition the quantity liberated is increased with the higher temperatures used in sterilizing. In experiments, it was found that the relatively less amount of black in soldered cans as compared with double seam cans was due to the use of zinc chloride in the flux used in soldering and capping the former. Exceedingly minute amounts of zinc chloride when in the headspace of the can, prevent blackening as the hydrogen sulphide combines more readily with the zinc salt to make a white zinc sulphide than with the iron. It takes from ten to twenty times as much zinc salts added to the corn to have the same effect in preventing blackening as when present in the headspace on the can. The use of resin flux on the side seam of the can in order to insure brightness has further eliminated the zinc so that the trouble due to black corn has naturally increased with the use of the open top can.

The effect of the first lacquers was to give the corn a peculiar foreign taste which was objectionable but this has been corrected. Occasionally a foreign flavor is discernible after a time and increases with age. A summary of this experimental work was presented at the convention of the National Canners Association in 1920 and published in the trade journals at that time.

A means of partially disguising, though not preventing the trouble, is to shake the can vigorously so that the patches of black are broken up and mixed with the corn. Machines have been developed for the purpose. The work is usually done just before labeling and shipping the corn.

Discoloration Due to Copper

Another form of discoloration that gives a decidedly gray or dark hue to corn, as though it were dirty, occurs when first starting machinery for the season, after a shutdown over Sunday or a holiday, or even in some cases the first cans for the day. This has been determined to be due to the corn coming in contact with untinned metal, especially copper. Thorough washing and scrubbing only partially overcome the difficulty. The manufacturers of the machinery have met the situation in a large measure by using monel metal, stainless steel, heavy tinning, porcelain and glass-lined tanks and hoppers so that the amount of gray corn is small by comparison with that produced fifteen years ago. Nevertheless it is well to flush out all the machinery immediately before starting the corn through the line and to set aside the first few cases and thus prevent the cans becoming mixed into the general pack.
Viscosity Determination

A laboratory method of determining the consistency of corn, based upon the use of a viscosimeter has been proposed by Charles J. Meister.* The values which he obtains are only relative in that one batch may be compared with another. Its advantage lies in that it is fairly simple and gives a definite standard of measurement for comparing different lots of corn.

"The apparatus consists of a Stormer viscosimeter, which is a standard piece of chemical equipment. This instrument is used for determining the viscosity of various liquids, but, so far as is known, it has never been applied to canned corn. At the top of the instrument and to the left a dial records the revolutions of the cylinder just below it. At the right, suspended by a cord, is a weight which is fastened to a reel at the axis of a large wheel at top of the instrument. This large wheel is geared to the axis of the cylinder.

"The can of corn placed just below the cylinder is first allowed to stand at room temperature for several hours so that it is very close to 70° F. Temperature causes a variation in the consistency, so it is very necessary that all determinations be run at the same temperature in order that all results will be comparable. After the can of corn has reached the desired temperature, it is shaken well, opened, and stirred well with a spoon. The can is then placed on the platform of the apparatus and raised until the top of the cylinder is half an inch below the surface of the corn. At this stage, the hand on the dial should be about five points below zero, or at about 95. The reel at the top of the large wheel should be turned until the weight is raised as high as possible. At the instant the hand reaches zero, a stop watch is started. This is allowed to run unmolested until the hand makes one complete revolution, and as it passes the zero mark the second time one hundred revolutions have been made by the cylinder immersed in the corn, and the watch should then be stopped. Thus, we have measured the length of time required for the cylinder with the above weight to make one hundred revolutions in a certain can of corn of a definite consistency. This instrument is sold with a one hundred and fifty gram weight, which was found to be too light for use on corn of the average consistency. In our experimental work we had a series of weights made up as follows: 150 grams, 300 grams, 450 grams, 600 grams, 750 grams, and 1,000 grams. We tried to find one weight which could be used for all variations of consistency. It was finally decided that 750 grams would fill these requirements. When the cylinder makes one hundred revolutions in less than seven or eight seconds, the corn is so thin that it would be called sloppy. When the corn is so thick that the cylinder will not turn using this weight, it is too heavy for the trade in any locality, especially as a fancy corn.

"We have been using this instrument at our plants for the past few years and find that at 70 degrees, using a 750-gram weight, if one hundred revolutions are made in around six seconds, the corn is too thin for good fancy quality. If it takes fifteen to twenty-five seconds, we call it medium consistency. If forty to sixty seconds are required, the corn is considered heavy. Seventy-five to one hundred is very heavy, and above this is too

thick to be sold as fancy corn unless on special order. There are some buyers who require an extremely heavy consistency for their label.

"The principle involved in the operation of this apparatus is the brake effect on the cylinder when immersed in liquids of low or high viscosity. In a thin liquid the cylinder will spin quite easily and it will only take it a few seconds to make one hundred revolutions. If the substance to be tested is a thick, heavy mass, it will hold back on the cylinder and cause it to revolve very slowly. When the cylinder is revolving so slowly that it is just moving, it will take four to five hundred seconds for one hundred revolutions."

The test is far more delicate than the spoon test and yet is so simple that little experience is needed to make it. It is made a day or two after the packing and again upon shipping and a record kept of the kind best suited to various customers in the different sections of the country.

Hominy

Hominy, samp, and succotash are terms which the first immigrants learned from the Indians for preparations of corn which they used in their crude culinary art. Of these, hominy is particularly interesting for it refers to a preparation in which lye leached from ashes or the application of wet fresh ashes is used to soften and to remove the hull, then washing the corn to remove the lye or ashes and finally boiling the corn until fit to eat. It was used especially by the Indians of Maryland, Virginia, and westward. Later, when the whites moved to the country which is now the Central states, they found those Indians made hominy in the same manner. Compared with the ordinary methods of preparing food, this represented a decidedly advanced step, possibly the most advanced in their art of cookery. The principles employed were adopted by the whites and lye hominy became an important item in the diet of the pioneers. It is still frequently used by country folk, miners, and those engaged in hard labor, and occasionally by many others. There is something about lye hominy that is more pleasing and satisfying than the machine made preparation, known as "pearl hominy." It is still made in the home in many places and in batches of a bushel or more and sold to the neighbors or in the local markets, the batches being made daily or at short intervals.

The use of lye in the preparation of a food product is unusual, the outstanding exception is that it has been used for centuries in the treatment of olives to free them of their natural bitterness; and also for a hundred years or more in a very limited way to remove the skins from certain fruits as pears, and more recently for peaches, figs, and vegetables, as peppers, tomatoes, carrots, and sweet potatoes, where the outer layer can be dissolved quickly and the action of the lye checked before the tissues underneath are attacked, but not used for the grains. It is also used for removing the fibrous divisions of grapefruit.

Equipment

The preparation of hominy necessitates only the simplest kind of equipment and very little hand labor. A plant operating one line at the rate of one thousand cases per day will require one washer for cleaning the corn,
and for this the squirrel cage type answers the purpose very well; tanks for lyeing and soaking, the number being dependent upon the size and whether the soaking be done over night or for only a few hours; in the former case, it requires about 26 tanks 2 by 6 feet and in the latter one-half that number; one huller, either a special machine or a coarse cyclone; a hot washing machine which may be a standard blancher operating very slowly and discharging the hulled grains into hot water in a soaking tank; an inspection table; filling machine; exhaust box; and retort.

It requires from 8,000 to 10,000 gallons of water to handle a thousand cases of hominy, and owing to the irregularity in the use of steam, 50 horsepower are needed.

Isaac V. Smith, of Delphi, Indiana, was the first to adapt the home method of preparing lye hominy to large scale or commercial production and to preserve the product by canning. His first experiment consisted of only six cans and was made in October, 1896. On November 1st of the same year, he made a factory pack of 800 cans and thereby launched a new industry, one which has grown slowly and steadily until in 1929 the pack amounted to nearly 1,765,000 cases. Or, to put it in another way, the kitchen trial in which less than a nickel’s worth of corn was used has grown until the annual output is valued at about two and one-half million dollars. Indiana has always held the lead in packing this product.

Corn Used

The corn used for hominy is white field corn with a rather broad, flat, plump grain. It may be either of the flint or dent strains, the latter giving a smoother appearance in the final product. Yellow corn will make hominy but as the color is objectionable, none is used. Sweet corn is unsuitable. The corn should be well matured and dry, preferably of not over 14 per cent moisture content. New corn or moist corn gives a crummy appearance and many grains break; furthermore, the action of the lye is not as uniform as in the dry grains. The hull is removed a little more easily than with old corn. After shelling it is best that the corn be screened to eliminate the tip and butt grains as they are irregular in shape and size, are not acted on evenly by the lye, nor present as attractive an appearance as the body grains.

Preparation

Hominy is made in batches, owing to the time required for the lyeing and boiling out. A definite quantity of corn is weighed as a unit, from five to eight bushels for small tanks to as large a quantity as can be handled, covered with water, heated, and the proper amount of lye added. The first tanks used were pickle vats with the corn filled to a depth of not more than 6 to 8 inches, due to the difficulty of stirring. Rakes and paddles are used so that all the grains be treated uniformly. Mechanical stirrers were then added which helped and later special apparatus was developed to do the work. Galvanized iron tanks soon displaced the wooden ones as they could be made light and mounted on low platforms to be moved about on trucks, and had the added advantage of convenience in handling and also in economy of floor space. These were made round at first, then oblong, about 6 feet long and 2 feet wide. Such tanks have sufficient capacity to treat about eight bushels of corn. A draw-off is provided at one end for quick
drainage of the lye or water. They have two disadvantages, one is that the corn comes in contact with more or less iron which favors some general discoloration of a bluish or grayish character, and the other, stirring of the lye must be done by hand, which is not uniform, resulting in some grains being over or under treated. The glass-lined tank with mechanical stirrer is undoubtedly best for permanent installation. An improvised tank made of a large barrel-type churn provided with a heating pipe was found to be highly efficient, the slow motion giving a perfectly uniform treatment without producing a broken or a crummy effect on the grains. This suggests that a monel metal drum tank might be a logical device for the purpose.

The usual procedure is to fill the tank with just sufficient water to cover the corn when that is added later, the amount of water being determined by experiment and the tank marked accordingly. The water is brought to the boiling point by directing live steam into it, which is effected by means of a hose and piece of pipe. The washed corn is then dumped in and the heating continued until the boiling point is reached. Any scum arising is skimmed off. A solution of lye is added in such quantity as to make approximately 2 per cent and this also is determined by experiment. A two by six foot tank requires approximately 50 gallons, or 400 pounds of water, to cover eight bushels of corn, and a 2 per cent solution takes eight pounds of lye or one pound per bushel. The solution added is made with two pounds of lye to the gallon. The lye available for this purpose is commercial caustic soda and may be rated in the trade as 76 per cent sodium oxide or 98 per cent sodium hydrate, the two being the same but expressed differently. Some trade preparations are also available and claims made that they are superior for the purpose but upon this point we have seen no comparative data. The steam is generally turned off the tank, the lye added and then quickly and thoroughly mixed. It is important that the batch be hot as the action of the caustic is intensified by heat and thus the time for loosening the hull is shortened and also a lesser quantity of lye needed. It requires fully 50 per cent more lye to work equally well when the temperature is below 180° F. than when near boiling. The time required for the lyeing varies from 20 to 45 minutes.

Experience has taught that about a 2 per cent lye solution is the most practical and that some modification may be made above or below in accordance with the condition of the corn, less for new or soft corn and more for old and very dry grain. Solutions in excess of 2 per cent are likely to cause more or less lye burning and those containing less than that necessitate too long time. The amount of solution used governs the time required, in two batches where the same strength solution is used, but one having twice the volume of the other, in the one with the larger volume the time is shortened though not in proportion to the extra volume. Lye is taken up rather rapidly by the corn so that after a few minutes a 2 per cent solution is reduced in strength if the volume be limited to just enough to cover. Some of the variation in the time required for loosening the hull is doubtless due to using an insufficient volume. The little work which has been reported upon this phase of hominy making is lacking in some of the details necessary to a complete understanding of the subject.

As soon as the skin slips easily between the thumb and finger, the lye is drained and the corn covered with fresh water to check the lye. The
corn is then run through a hominy huller, which consists of a short, truncated cyclone using a coarse wire screen and has capacity for a thousand cases per day. Originally a squirrel cage pea-washer was used, also a cyclone pulper made to serve the purpose. The huller gets rid of the tough skin and most of the tips, leaving the grains practically whole, if good stock has been used and the stirring and hulling done without using too much speed or force.

The corn is discharged from the huller into another tank and boiled from 15 to 20 minutes, allowed to stand about the same length of time, and then the water drawn off. This is done primarily to get rid of the lye but a secondary effect is that the corn takes up water. The practice at this point varies. In the older method the corn was allowed to stand in the tanks in cold water over night, the water being changed once or twice, and the swelling of the corn took place slowly and uniformly; the next morning the corn was given a short boil to remove any trace of lye and to soften the kernel slightly. It also had the effect of producing a brighter color just before the canning. In this method the corn was swollen to practically its limit before going into the can. In the short method, the second boiling follows within a half hour after the first, and, if necessary, a third boiling may be made. The corn becomes swollen but not to its limit, so that allowance must be made for some additional swelling in the can. This factor can be determined by a small trial batch. The objection to the first method is the amount of time required and also the tendency to sour if the water becomes warm. It is unsafe to use wooden tanks for this purpose as they become infected with organisms which cause flat sours. To offset this the quality of the hominy is considered to be better than by the short process. In the short process more starch is set free which makes the brine in the can look milky and sometimes a thickening of starchy matter occurs at the bottom of the can.

Whatever preliminary treatment be used, the cans should be filled so that the corn will not come to within one-half inch of the top and should be well covered with brine. Hominy is a product that needs a slack fill if the best appearance is to be preserved. One and one-half per cent salt is used in making the brine.

Hominy needs to be well exhausted, or above 150° in the center of the can and cooked at 240° for 75 minutes or 245° for 60 minutes. It is more difficult to sterilize than one might expect from the ease with which heat is conducted through the mass. To go above 240° increases the tendency toward discoloration and also sets free more starchy material to form a more or less pasty mass in the bottom of the can, both conditions detracting from the appearance though not affecting the quality of the food. The cooking should be followed by prompt cooling. With the agitating cooker, the temperature can be raised and the time shortened without producing these objectionable effects.

Hominy is packed principally in the No. 2½ cans, the contents of which should not be less than 1 pound 13 ounces. No. 2 and No. 10 cans are also used, the contents of the former should weigh not less than 1 pound 4 ounces and the latter not less than 6 pounds 11 ounces.
Label Weights
(Sp. Gr. 105): Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.;
No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb.
4 ozs.; No. 2 ½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 2 ozs.;
No. 10, 6 lbs. 9 ozs.

Troubles
The canning of hominy is attended with some troubles, the most impor-
tant of which is the production of a black discoloration, which is generally
most pronounced in the germ portion, or in extreme cases it may affect the
entire grain. This was recognized early as one of the handicaps in produc-
tion and much work was done by individuals to overcome it. The ma-
majority of packers resorted to the use of sulphite of soda in the first boiling-
out water and depended upon the subsequent washing to remove the sur-
plus. The cause was first determined by Duckwall in 1908 as being due
to hydrogen sulphide formed in the corn during the cooking and combin-
ing with the iron of the can to form black sulphide of iron. The amount of
blackening is related to the alkalinity of the corn and the temperature used
in the cooking, the greater the alkalinity and the higher the temperature,
the more blackening occurs. The condition may vary from only a few
gains showing some grayness or blueness to a large part of the kernels
showing discoloration of every degree from a gray tint to a black, and the
brine of a bluish tint. Ordinarily only a small amount is discolored, con-
fined to that projecting in the headspace above the brine, along the side
seams, the cap hole, or the rings impressed in the top. These are the points
where the iron is most exposed. When the consumer receives a can, the
gains are generally mixed throughout the contents as a result of handling
and shipping so that it naturally suggests that some poor or unfit corn was
used in the making. The worst cases of discoloration have been in hominy
packed for use in the South as in that case no attempt was made to remove
all the alkali, the trade seemingly having a preference for that which is
slightly alkaline. The tip and germ show discoloration first and to a more
marked degree than the starchy portion, sometimes presenting the appear-
ance of being diffused from the germ. Prevention consists in the uniform
application of the lye for as short a time as possible to remove the hull,
thorough washing after boiling to remove the lye, quick cooking in an
agitating cooker, or holding a low temperature in the retort, and prompt
cooling. Lacquer-lined cans have been tried, the enamel C type being best.

Another trouble investigated by Duckwall at the same time was sweet
hominy. This he found due to two causes: one, a lack of sterility, and
the other, to some hydrolysis of the starch as a result of processing. The
first case corresponds to a flat sour in other vegetables but in this case the
flavor is sweetish. It is associated chiefly with non-cooling and stacking of
cans while warm. No gas, or almost none, is formed, and no odor is
noticeable upon casual examination. The grains have a dead color and a
sweetish taste. The trouble was found to be due to bacteria of the same
type as found in flat sours in other vegetables. Both of these observations
have been confirmed.

Hydrolysis is said to occur in hominy cooked at more than 245° F. and
the heat maintained for too long a time.
Pink hominy was also common in the early period of manufacture, due to stacking in the warehouse before cooling.

**Corn Meal Mush**

The use of corn meal mush dates to the earliest use of ground corn by the immigrants and doubtless had a prior usage by the Indians. It held an important place in the dietary of the early settlers of the eastern and central states and continued to do so until as late as fifty years ago, but since then it has gradually given place to other cereal preparations and foods. The freshly prepared mush was used either with or without milk as porridge and when allowed to cool was fried, usually in pork drippings or bacon fat.

Mush may be canned and makes a distinctive product for slicing and frying.

Yellow corn meal is used in the preparation of this product, the choice of color being a matter of custom, as the white for hominy. It is easy to prepare though it can not be made cheaply since it requires long boiling in comparatively small batches.

Mush is made by boiling corn meal in water, with sufficient salt added to suit the taste, until it attains a smooth, uniform thick consistency. A kettle fitted with a stirrer is filled to less than half its capacity with water, then brought to a boil and the meal added in small quantities at a time, thoroughly stirred until practically an equal quantity of meal is added. The mass is then boiled gently and kept constantly stirred for a period of an hour and a quarter to an hour and a half. When finished, it should have a heavy smooth consistency so as to drop from a spoon in large flakes.

It is filled directly into No. 2 or No. 2½ cans and given a final cook at 240° F. for 60 minutes for the No. 2 and 70 minutes for the No. 2½ cans.

When cold, there should be no free liquid in the can but the mush be in one solid but moist mass. The contents of the can is removed as one piece, then sliced as thick as desired, and sautéed or fried. In frying, if the slices are first coated with flour, the appearance and flavor are improved.

**GREENS**

The term greens is used in a broad sense for the young tender shoots and leaves of various plants as beet tops, chard, dandelion, kale, mustard, turnip, sour dock, spinach, asparagus, lettuce, etc. It seems to have been first applied especially to the early growth gathered in the spring, but gradually extended to the young succulent leaves used in salads or as pot-herbs and without regard to the season. There is no sharp line in its application, merely subject to local custom. In canning, asparagus is most often considered separately because of the special treatment which must be given. Spinach is the most important plant in the class, the total pack amounting to several millions of cases annually while the others aggregate only a few thousand each. The methods followed for all are the same as for spinach.

The nutritive value is not the first consideration with any of these, but the desire for variety and the imparting of flavor to other foods. Much has
been made of the vitamin content of all of these and especially of turnip greens. Experiments indicate that this last is a good source of vitamin A, and a rich source of vitamin C.*

Macedoines

Mixed vegetables for salad are standard preparations abroad where the salad has formed a part of many more meals than in this country. Very little attention was given to the canning of such preparations here until "Fruits for Salad" became an outstanding success. Since that time, a number of firms have undertaken the packing of mixed vegetables but the products have not met with any special demand.

One seemingly has a wider range from which to make a selection for a vegetable macedoine than for a fruit mixture for salads as the list includes artichokes, whole, if small ones, or hearts; asparagus tips; beets; beans, both lima and the stringless pod; brussels sprouts; carrots; cauliflower; celery stalks; corn, whole grain; parsnips; peas; pimientos in strips, squares and fancy shapes; and some other vegetables which are less common. The fact that the cabbage group, including brussels sprouts, cauliflower, and turnip, have such a dominating flavor and are not liked by many persons eliminates them from many combinations. The stringless pod bean, wax bean, and green shelled bean, such as the lima, are nearly always made a part of the mixture. The carrot, either small or whole, cut in long strips, or in fancy designs, is another ingredient that is practically constant as it imparts a pleasing, contrasting color. The fourth may be artichoke, asparagus, celery, or beet, if the stronger flavored group is to be avoided.

In the packing of macedoines, it is desirable to have as much as possible of the product fresh since recooking injures the flavor, and frequently softens the product. In many places it is possible to plant so as to have the lima and pod beans, the carrots, beets, and turnips ready for packing at the same time, but like fruits for salad, the work can be done from prepared stock at any time. The beet needs an inside lacquered can to conserve its color so that may well be supplanted by something else. Moreover, it gives up some of its color to the brine which is objectionable.

The preliminary work through the blanching is the same for each vegetable as when packed separately or if any difference be made, it is that the blanch be made heavier. At the filling table, each vegetable is put in the can separately and in the proper proportion for the number of services desired. The usual procedure is for each vegetable to be added by a different person in order that the work be done with greater accuracy and also to avoid mistakes or omissions. A one and one-half per cent brine is added and a cook of 240° F. for 25 minutes is given for No. 1 and No. 2 cans. Heat penetration takes place readily in such a product so the cooking need not be excessive. Large cans are inadvisable owing to the softening of the product.

Mixed vegetables are also prepared for soup stock, the pod bean cut into short lengths, the carrot, parsnip, rutabaga or turnip diced or cut into fancy shapes, and the other ingredients prepared in the usual form in which they

*Georgia Agricultural Experiment Station, Bulletin 167.
appear in soups. The preliminary preparation through the blanching is the same as in the regular preparation for canning, then they are cut and mixed in the desired proportion and filled by machine the same as for soup. Where available, ham bones and ends may be cooked and the broth used in the brine for covering. The filling is done in Nos. 1 and 2 cans as stock for soup to be made with meat available or selected in the home, and in No. 10 cans for large kitchens.

**MUSHROOMS**

A number of large edible fungi are highly esteemed for their flavor and also for their effect in improving the flavor of other foods. They have been used for a very long time and more especially by those who could afford the better and more expensive things. There are also wild fungi which are poisonous which in general appearance bear a close resemblance to the edible types. The botanist recognizes differences between the different kinds of characters which are as distinctive as those between wheat and oats or wheat and rye and naturally it is imperative that the packer have the proper training to make the distinctions before attempting to prepare them as food. Numerous books and bulletins are available which treat of the minute details for identification of the species. Commercial packing of mushrooms is limited to the cultivated types and the growing conditions are such as to preclude the possibility of the objectionable varieties.

There are only a few of these fungi that are used in any considerable quantity and still fewer that are packed and distributed in commerce.

The mushroom or champignon (*Agaricus campestris*) is by far the most important and the only one for which there is a complete system of cultivation and the only one canned in this country.

The fungus grows singly or in clumps. It consists of a central stalk generally about 3 inches in height and $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter, surmounted by a cap which when closed is from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in diameter, but upon opening and expanding may reach 3 inches in diameter. In the early stage the cap presents a flattened globular shape and when expanded, it is flattened umbrella-like. The underside of the cap has many gill-like projections extending inward, of a rather pinkish color at first in the light specimens, light brown in those which are darker, but both becoming black as they mature. The stem is from a light cream to a light brown and the cap from light, almost white, to brown in color.

The mousseron, button mushroom (*Champignon muscat*) is a small variety with short stem and small plump button-like cap which opens in a bell shape on maturity. It is whitish yellow on top, covered with a dark skin. It has a distinct flavor and a musk-like odor. It is a particularly desirable variety, obtained wild in France.

The morel or French morelle (*Morchella esculenta*) is smaller than the common mushroom, grows to a height of 4 or 5 inches and has a cone-shaped cap with reticulations on the surface. It retains a constricted form at the lower edge of the cap instead of exposing a large under surface at maturity. The color is light yellowish with some brown. They are found wild in damp places and are prized for their distinctive flavor. They are more closely related to the truffle than to the true mushrooms.
Boletus or cepes (Boletus esculentus) resembles the common mushroom in size and form but with more yellow in the color and instead of gills on the underside of the cap, the surface is perforated with numerous holes. It has a strong flavor making it particularly valuable for use in sauces. Since it is injured less by drying than are other forms, it is generally conserved in that way and is imported in large quantity.

The truffle (Tuber aestivum) is the most valuable of all the fungi and the least understood until within a very short time. It grows only in the forests of France, chiefly in the Perigord province. No part of it appears above ground and until recently it was located with the aid of a pig or trained dog. It is obtained naturally only during the three months of winter but a new method of artificial propagation promises to extend the period. It is irregularly spherical or elongated, fairly solid, and with a reticulated skin, varies from less than an inch to 3 inches in cross section, and is dark to almost black in color. The flavor and aroma are considered the finest. They bring from one to four dollars a pound.

Mushrooms

The use of the mushroom, that is, the wild type found growing in pastures and upon lands where there is an abundance of decaying organic matter, is very old. It was used by the Egyptians, Greeks, and Romans in their stews and probably much earlier. It has been observed that uncivilized tribes at present eat the same class of fungi so there is no reason to doubt but that the same thing occurred with our early ancestors. The Greeks and Romans and those who followed had to depend upon such specimens as they could find as they recognized it as a plant without seed but knew of no means for its propagation. They observed that it was most abundant in pastures and along trade routes where animals were tethered or fed and believed it to be due to decomposition of animal or vegetable matter in the soil but that was the extent of their knowledge.

Horace, the poet, eulogized the fine qualities of the mushroom just before the Christian era.

Gibault could find no record of the culture of the plant prior to the 17th century and cites Olivier de Serres, 1600, as the first to refer to such a culture. It appears that the Parisian market gardeners observed that mushrooms were most numerous in the fall in their melon patches where the land had been manured very heavily and decomposition not fully completed. Since the growths were spontaneous, they made the deduction that by making deep beds or trenches filled with manure and covered with a layer of soil they could be produced, but the result of their efforts was that sometimes a crop of fungi was obtained but more often not. These beds were in the open. They had discovered only one factor, a definite relationship between decomposing organic matter and the appearance of the plant but not the other conditions necessary to insure a crop. They had at least progressed beyond the learned Englishman, John Evelyn, who declared "that they were substances put in the world by the thunders of autumn."

The popularity of the mushroom was such that the gardeners made every effort to determine the secret of its growth and especially since the resulting compost could be used for enriching their gardens if they failed to produce a crop. They next discovered that it was advantageous to throw
"the parings of mushrooms and the water in which had been washed those that one prepares in the kitchen" on the beds. This step was taught in the Jardinier françois, 1651. Another advance was made when they found that dampness was essential, so that if it did not rain, they threw water on the beds. The methods were improved to such an extent that they had mushrooms at almost any time though not with certainty. There was always enough success to warrant another trial rather than to give up in defeat. The certainty of a good price for those produced out of season was a lure that could not be resisted. Their botanists also discovered that the white filaments which they saw in the manure were connected with the reproduction of the plant.

It was not until 1749 that caves and cellars were utilized as places for making beds and the results were so much of an improvement that it gave a new impetus to the culture. A more uniform and better control of temperature and moisture with exclusion of the direct rays of the sun greatly increased the possibilities of market production. It was at the beginning of the 19th century that the great quarries under Paris were used and that led to a vast extension of the business. For years a couple of thousand or more persons were engaged in the production of a crop valued at more than $2,000,000 annually, and that not for a necessity but because of the character which it imparted to other foods. There was a continuous importation of dried and canned mushrooms from that source from 1850 up until the World War. In 1893, Dr. Rapin of the Pasteur Institute worked out a method of obtaining spawn and thus made it possible for the growers to seed their beds. Since then a number of others have worked along the same line and perfected that for which he provided a starting point. It can thus be seen that it took three centuries to bring this plant under cultivation, certainly a tribute to the persistence of the French. In this country the Bureau of Plant Industry developed a different method of obtaining spawn about 1905 and later Ferdinand Lambert of Chester, Pennsylvania, developed a method which attained considerable commercial importance.

Commercial Production

The packing of mushrooms is a specialty involving both the cultivation of the beds and the preparation in the factory. It is the kind of product that, owing to the evanescence of its aroma and flavor and the tendency to rapid decomposition, must be handled absolutely fresh and not from stock obtained on the market. The canning has been carried on in France for a long time and though never a large industry, it has been profitable by comparison with ordinary vegetables such as peas or beans. The dried mushrooms come to us from both France and Italy.

The first description of a method for canning mushrooms is given by Appert and is as follows:

"Mushrooms are taken from the bed when well formed and fairly firm. After having picked and washed them, they are put in a casserole on the stove with a bit of butter or some good olive oil so as to draw out the water. They are left on the stove until the water is reduced to half; then removed to let them cool in an earthen pan, after which they are put in bottles so as to give a good boiling in a water bath, etc."
Commercial packing of mushrooms is an innovation in the canning industry in this country, developed chiefly since 1918. It was stimulated as a result of the World War shutting off all the usual supply. Edward H. Jacob, who was the largest grower of the fungus, was induced to add a canning plant to his equipment with the result that he has since become the largest canner of that article. The center of production is in southeastern Pennsylvania, where 20,000,000 pounds, or two-thirds of the annual pack for the entire country, is grown. An earlier attempt at growing and packing had been made by Louis McMurray of Baltimore, in 1878. The importation of mushrooms at that time was so large that it looked as though domestic packing might be a profitable business. Mr. McMurray made preparations to compete with the French, and to do so on a large scale, but not having a background of experience either in the growing or in the preparation, the inevitable result followed.

Mushroom Growing

Briefly stated, the commercial growing of mushrooms requires special equipment and in addition training for the particular work.

The buildings for the growing beds are generally made long and low with a number of narrow units. These are preferably constructed of hollow tile because of its insulating properties since the temperature is held as close to 60° F. as possible, it is thus necessary to keep out heat in the summer and cold in winter. As an additional means of securing this temperature, pipes are installed to carry either cold or hot water as needed. Provision is also necessary for ventilation and the maintenance of a certain degree of humidity which is also controlled mechanically when the conditions for natural draft are unfavorable.
The beds are usually arranged in tiers one above the other in order to utilize the space to the fullest advantage.

Fresh horse manure, from animals bedded with clean straw and receiving grain with their hay, and clean loam soil are essential for the bed. Cow or sheep manure, manure containing disinfectants as cresols, street sweepings, or wood shavings are not satisfactory. Neither is the compost made of straw or other waste material by the newer synthetic methods employing chemical and biological activities.

The manure is composted in the open or under sheds on a clean place, the pile being made about three feet deep, six in width, and as long as desired. The soil to cover is steamed to destroy any undesirable fungi which may be present. The moisture is controlled to keep the heap moist but not wet and the whole forked over to prevent the temperature running too high, that is keeping it under 150° and preferably around 135° F, when at the height of its activity. Special machines have been built to handle the manure, lifting it out of the pile by a kind of hay fork and tearing it to pieces by a sort of modified manure spreader. This overhauling continues for a period of two months or more when the temperature subsides and the partially rotted compost is carried to the beds. It may be laid flat, about one foot in depth, or made in ridges about fifteen inches high and equally wide, though this latter method is not common in this country. It is again watched and when the temperature falls to 70°, it is ready to receive the spawn. This is distributed in small lumps about a foot apart. In about three weeks an inch of soil is spread over the compost and nothing further is done for about another four or five weeks when the first crop of fungi appear. The harvest continues for about two and one-half months during which the conditions are kept as nearly uniform as possible. Every trace of the beds must then be removed and the work repeated. A room can thus be used twice each year. The yield per square foot per crop is about one and one-half pounds.

With the use of culture spawn, strains may be selected which vary from almost white, through very light brown to brown. There is no observable difference other than color and since they are cooked and made a part of a gravy or sauce this is not a very important matter other than that it has been made so by the canners. With the purchasers taught to look for light color, it naturally follows that a light strain of the fungus is the more satisfactory.

**Harvesting**

Mushrooms are gathered daily when the caps are of medium size and before the veil breaks at the stem. The smaller sizes are preferred for appearance only but since taking them at that stage greatly reduces the yield, they are generally allowed to remain on the bed until nearly ready to open.

The picking is done in small or three-pound grape baskets, those having been found convenient for use on the beds and in the factory, and in addition affording excellent low cost protection to the mushrooms in small lots.

The mushrooms are trucked directly from the growing houses to the factory so that the time between the picking and their appearance on the trimming table is only from about one-half hour to an hour. It is this very
short period which gives the packer who raises his supply such a great advantage over the one who must depend upon the market. The mushrooms are trimmed at once, the women working directly out of the baskets and dropping the trimmed and cleaned material on a belt which carries it to the proper receptacle. The bottom is cut off the stem, any defects cut out, and any very brown spots are peeled. Insect attack, and diseases such as "bubbles" are not of frequent occurrence in a crop produced by the modern methods of controlling the composting and the conditions in the houses, whereas formerly both were serious. Nevertheless, inspection must be made for both.

![Grading Mushrooms](image_url)

The trimmers divide the mushrooms into three grades by the eye. Those above 1½ inches are classed as large; those from 1 to 1½ inches as medium; and below 1 inch as small. The belt is divided into three alleys by divider boards and the sizes put in the appropriate alley. One machine has been designed to do this work and is limited to the use of one firm since it is patented.

**Washing**

The mushrooms are next soaked from 10 to 15 minutes in order to loosen any adherent soil. This is a preliminary step to the removal of all dirt by means of small sharp sprays. If the soaking be omitted, the imbedded grit will not be removed and is sure to be found when the service comes on the table. The French method has long been to use light brushes when washing but the work can be done equally well by the combination of a short soaking and proper sprays. The washing brings out defects which did not appear at the trimming so they are conveyed from the washer on a belt for inspection and any defective pieces removed, also any extra long stems. The time of soaking is brief to avoid a soggy effect.
Some differences in practice occur in the washing. If the mushrooms are dark or it is desired to have them as light as possible in the can, about 0.3 per cent citric acid is added to the soaking water and there may or may not be about 3 per cent of salt. Formerly sulphites were used and still are abroad but that is neither necessary nor desirable. By using the citric acid before blanching very little is taken up and the greater part is removed in the blanching so that only a trace is left in the finished product. The better packers, using carefully cultured spawn, do not find it necessary to use any bleach and have a better product. The rinsed mushrooms are delivered into perforated buckets in order that there be no agitation nor movement to cause injury or breaking of the delicate structure when blanching.

The time for blanching is usually from 8 to 10 minutes and preferably at a temperature not to exceed 185° F. This seemingly long blanch is necessary to get shrinkage to the point where the cans do not appear slack filled after processing, and by using a moderate temperature there is not the same abstraction of flavor as follows when near the boiling point. The blanching may proceed in two stages and especially if citric acid or lemon juice has been used in the soaking tank. In the first stage the mushrooms are submerged until they reach a temperature of about 175° F, which takes from about 2 to 2½ minutes, are lifted out and rinsed with hot water, and then submerged in the second bath. The second bath is made no larger than is necessary to cover the mushrooms for the water in this bath contains juice extracted from the mushroom and is used for brining. Flavor is conserved, also, whereas further dilution takes place if a fresh brine be used. Krebs called attention to this in 1886 but as that was a period when sulphites were used generally for bleaching and appearance counted for more than flavor in the market, his advice was ignored. Madam Ray-
 mond advocates the use of perforated graniteware blanching vessels to avoid having the mushrooms come in contact with the usual metal ware. Edward H. Jacobs has improved upon this by using shallow perforated monel baskets and giving a steam blanch, thus conserving the natural juices.

**Filling**

Following the blanch, the mushrooms are given a cold spray, and filled into cans by hand, the amount being checked by weighing each can. The work is done directly from the blancher buckets to avoid any additional handling. The cans most used are the No. 1 which holds 8 ounces of mushrooms, 4 oz. (mushroom) which holds 4 ounces, and 2 oz. (mushroom) which holds 2 ounces, each exclusive of the brine. The mushrooms are then covered with liquor from their own blanching if steam blanched, or if treated in the old way by liquor from the second tank, plain 1.5 per cent brine, or brine with 0.2 per cent citric acid added if no acid was used in the soaking tank.

**Cooking**

The cans are exhausted to about 150° and formerly a cook was given at 230° for 25 minutes for No. 1 cans or 35 minutes for No. 2 cans. As far as reported this cook was adequate. The National Canners Association recommended 240° for all cans for 20 minutes except the No. 10 and that for 35 minutes. The French are partial to lower temperatures to conserve flavor and most often recommend 230° for 15 minutes for \( \frac{1}{2} \) liter cans or less, and 20 minutes for 1 liter. The German method is to use 244° for 10 minutes for \( \frac{1}{2} \) liter, 15 minutes for 1 liter, and 20 minutes for 2 liters.

The French pack mushrooms in glass for both home consumption and the trade and for this prefer a boiling bath, the time being 1½ hours on containers of less than 1 liter.

**Label Weights**

(Sp. Gr. 1.03) : 2 oz. (mushroom), 3¼ ozs.; 4 oz. (mushroom), 6¾ ozs.; 8 oz. (mushroom), 12½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 2, 1 lb. 3 ozs.

**U. S. Standards**

Effective June 20, 1936. The following paragraphs are inserted after paragraph 79 of Service and Regulatory Announcements, Food and Drug No. 4, Revision 3:

**Canned Mushrooms. Standard Requirement for Fill of Container.**

(Amount of packing medium)

80. Canned mushrooms are of standard fill with respect to packing medium when the drained weight of mushrooms equals or exceeds the following amounts:

<table>
<thead>
<tr>
<th>Trade Designation</th>
<th>Drained Mushrooms, Ounces</th>
</tr>
</thead>
<tbody>
<tr>
<td>202x204</td>
<td>2</td>
</tr>
<tr>
<td>208x200</td>
<td>2.4</td>
</tr>
<tr>
<td>211x212</td>
<td>4</td>
</tr>
<tr>
<td>211x304</td>
<td>4.9</td>
</tr>
<tr>
<td>211x400</td>
<td>6.1</td>
</tr>
<tr>
<td>215x408</td>
<td>8.5</td>
</tr>
<tr>
<td>300x400</td>
<td>8</td>
</tr>
<tr>
<td>300x407</td>
<td>8.8</td>
</tr>
<tr>
<td>307x408</td>
<td>11.8</td>
</tr>
<tr>
<td>307x409</td>
<td>12</td>
</tr>
</tbody>
</table>
Pending the issuance of standard fill requirements for cans of less than usual sizes, mushrooms in cans of a size not mentioned above will be regarded as of standard fill with respect to packing medium when the drained weight of mushrooms equals or exceeds 1 ounce for each 3 cubic inches inside capacity of the container. Drained weight is determined by draining the contents of the container 2 minutes on an 8-mesh sieve, with the sieve tilted as much as possible without shifting of the mushrooms. The solids remaining on the sieve are transferred to a dish and their weight determined.

**Substandard Fill Statement**

81. Canned mushrooms which fail to meet the above requirement shall bear the substandard statement in the form and manner prescribed in paragraph 10 (2).

**Note on Declaration of Weight on Canned Mushrooms**

82. The prevailing custom of declaring quantity of contents of canned mushrooms is in terms of drained weight. This being at variance with the usual practice of declaring total net contents of canned foods with an edible packing medium, declaration should be made in such form as to leave no possibility of consumer deception or confusion. “Drained Mushrooms ______ oz.” is regarded as a satisfactory type of statement.

10. Canned foods which fail to meet the above standard shall bear the substandard statement, in the form and manner prescribed in paragraph 1. The first line of the legend shall be “Below U. S. Standard.” The explanatory statement shall be:

(1) In case of excess of head space only:

“Slack Fill”

(2) In the case of excess packing medium, whether or not the head space is excessive, the two-line statement:

“Slack Fill
Contains Excess Added Liquid”

This regulation supersedes S. R. A. 225 and S. R. A. 270.

**Other Methods of Packing**

The French also prepare the mushrooms with vegetable oil and butter. The cleaned mushrooms are allowed to dry so that no free moisture is present on the surface. They are then placed in wire baskets and dipped in hot oil or butter the same as frying potatoes in deep fat. The temperature is not given but evidently it is not very hot, probably about 250° F. so that the mushrooms reduce to about one-half in 5 minutes. The cans are filled, the hot oil or butter added, and the cook made the same as for the regular pack.

Patent No. 1,018,909, issued February 27, 1912, to E. H. Jacob, West Chester, Pennsylvania, is for “A Process of Preserving Mushrooms”:

My improved process has for its leading object the preservation of mushrooms so as to prevent the loss of their natural flavor. This object is accomplished, in the preferred practice, by subjecting the mushrooms to an evaporating operation at a temperature of from 100 to 150 degrees F. until their weight has been reduced to approximately one-half through loss of water; then washing in cold water to cleanse and freshen the product; then dipping, for a period of from 1 to 3 minutes, in a bath of scalding water containing citric acid and salt in the approximate proportions of 12 gallons of water, 1½ ounces of citric acid, and 5 pounds of salt; then coating with hot oil, suitably by dipping in hot cottonseed or olive oil, and then heating for a period of from 10 to 30 minutes (depending upon the bulk treated) at a temperature ranging from 212 to 250 degrees F., suitably by placing the mushrooms at a temperature of about 150 degrees F. in a container which is closed and heated to effect the desired sterilizing or processing.

While the foregoing treatment has been found to effect the preservation of mushrooms without loss of flavor so that the preserved product may not be distinguished from the fresh it will be understood that such treatment may be varied by omitting certain operations, as washing in cold water and dipping in scalding water containing citric acid and salt, and by modifying the degree of the treatment as by changing the
time and temperature of the operations; or the mushrooms may be sterilized in water or brine directly after being subjected to the evaporating operation. It is important, however, that the treatment shall not drive off or cause the loss of natural juices of the mushrooms, as by the use of high or prolonged heat in effecting the evaporation of the water which is preferably driven off at a temperature between 100 and 150 degrees F.

**Troubles**

Trouble in the canning of mushrooms was first investigated by Sarthou in 1904. He found discoloration due to two causes, one from chemical action from the sulphites used in bleaching the fungi combining with the metal of the can, causing black spots and very small particles of black floating in the liquor. The other, a general blackening of the contents due to bacterial action. The latter was accompanied by putrefactive odor characterized by dominance of hydrogen sulphide.

**Food Value**

The mushroom is in reality a condimental food though it is commonly supposed to be highly nutritious. United States Department of Agriculture Bulletin No. 79 gives the chemical composition as follows:

<table>
<thead>
<tr>
<th></th>
<th>Mushroom</th>
<th>Morel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>91.30</td>
<td>89.54</td>
</tr>
<tr>
<td>Ash</td>
<td>.50</td>
<td>1.08</td>
</tr>
<tr>
<td>Protein</td>
<td>3.75</td>
<td>3.06</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>3.50</td>
<td>1.60</td>
</tr>
<tr>
<td>Fiber</td>
<td>.80</td>
<td>.91</td>
</tr>
<tr>
<td>Fat</td>
<td>.20</td>
<td>.50</td>
</tr>
</tbody>
</table>

**S. R. A. No. 225. Declaration of the Quantity of the Contents of Mushrooms, Olives, and Pickles.**

The bureau has investigated trade usage in the packing and sale of olives in brine, mushrooms in brine, and also pickles in brine, vinegar, and sweetened vinegar.

It is of the opinion that the quantity of the contents should be declared upon packages of mushrooms in brine in terms of the weight of the drained mushrooms.

**OKRA**

*Hibiscus esculentus*

Okra or gumbo, as it is frequently called, is a plant of somewhat uncertain origin but the preponderance of evidence seems to point to an early importation from Africa. It became generally and widely distributed in the South and held the same relative position in the garden as the string bean in the North. The plant was first described as being used by the Egyptians in the 13th century so that it does not occupy a very ancient place among foods. There are closely related species found growing in all warm countries but they are considered either ornamental or fiber producing plants and not used as food.

**The Plant**

The okra is a semi-tropical plant and fairly sensitive to cold which accounts in part for its more general use in the South. Furthermore, it needs a longer growing season than is afforded in the North. It is a perennial but treated as an annual under cultivation. There are two varieties, one
growing about 5 feet in height with rather hairy drooping pods. The other
dwarf, from 1¼ to 2½ feet in height with nearly smooth erect pods. The
dwarf variety is preferred. In general appearance it resembles the cotton
plant and the ornamental Rose of Sharon, the flower being large and showy,
bright yellow with a purplish center. The edible portion is the large seed-
pod used while green. The pods are five-parted, from ½ to ¾ of an inch
in diameter and from 1½ to 4 inches in length. The walls are thick and
succulent and within are numerous seeds surrounded by a mucilaginous
substance.

The plants are easily grown and are ordinarily planted in rows 3½ feet
apart and 18 inches in the row. They thrive best on a warm loam soil, bear
continuously if kept stripped of pods, and may live for two or three years
if not injured by frost.

Canning

The packing of okra is confined to the South, nearly all being done in
Mississippi and Louisiana, and is a small item commercially.

The pods are picked before they are full grown or begin to toughen, and
are handled in baskets. No special machinery has been developed for grad¬
ing them to size but some hand sorting is generally done to take out those
less than 1½ inches in length so as to use them in a fancy grade. The pods
are thoroughly washed, the stem cut off without opening the seed cells, and
followed by blanching until they are pliable which generally takes from
2½ to 4 minutes. The entire pods may be packed into cans, leaving the
cutting to lengths to be done by the consumer at the time of opening. Only
pods under 2½ inches in length are used in this way. It makes an attractive
appearing product with the added advantage that the free movement of the
water between the pods makes them easy to sterilize. The larger pods may
be cut into ¼, ⅜, or ½ inch lengths after blanching and then be packed into
cans. A string bean cutter makes an efficient device for this purpose. The
cutting cannot be done before blanching as done with most vegetables
owing to the formation of a thick mucilaginous material in the seed cells.
A two per cent brine is used to fill the interspaces, then a short exhaust of
about three minutes given. It would seem more logical to give a rather
long exhaust, as eight minutes, in order to displace the air and gases more
completely and also to obtain a higher heating of the product.

Okra is easily sterilized and for a long time No. 3 cans were heated in
an open bath for one hour. A safer procedure is to use 236° to 240° F.
for 30 minutes for the No. 2½ size which has displaced the No. 3. Some
okra is also packed in the No. 2 size for household use. A considerable
amount is packed in No. 10 cans for reuse in making soup and gumboes.
The process on this No. 10 size is 236° F. for 45 to 50 minutes.

Label Weights

(Sp. Gr. .99) : 8Z Short, 7¼ ozs.; 8Z Tall, 8 ozs.; Picnic—No. 1 East.
10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 15½ ozs.;
No. 2 Special, 1 lb. 2 ozs.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 1½ ozs.; No. 3,
2 lbs.; No. 5, 3 lbs. 6 ozs.; No. 10, 6 lbs. 3 ozs.

Mixtures

Mixtures are sometimes made of okra and tomatoes or of okra, tomatoes,
and whole grain corn, the proportions of each being varied to suit the
ideas of the packer. The cook is the same as for okra.
Composition

Okra is a constituent of many soups and is an essential ingredient in any gumbo. It is considered very nutritious and it is a common observation in the South that children given a liberal quantity in their diet are generally in better condition than those given other foods. The flavor is not distinctly nor particularly agreeable but after a taste is acquired for it, it is much liked. It has been little known in the North until within the past decade.

The composition of okra is very similar to the string bean and is given as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>87.41</td>
</tr>
<tr>
<td>Ash</td>
<td>.74</td>
</tr>
<tr>
<td>Protein</td>
<td>8.99</td>
</tr>
<tr>
<td>Fiber</td>
<td>3.42</td>
</tr>
<tr>
<td>Starch, sugar, etc</td>
<td>6.04</td>
</tr>
<tr>
<td>Fat</td>
<td>.40</td>
</tr>
</tbody>
</table>

**PARSNIP**

*Pastinaca sativa*

This plant which at one time held an important place among vegetable foods of Europe, particularly for use among the rural population and poor people, was displaced by the introduction of the potato from the New World. Its status was reduced from the accompaniment of the entree to that of a flavoring for soups, or as an occasional side dish.

The plant is a biennial, indigenous, and common to southern Europe, occurring more sparsely northward and even into England. In its wild stage the root is small, whitish, tough, and not edible. It has been known for a long time but did not acquire the importance of being cultivated nor adopted into culinary use until early in the Middle Ages. The earliest reference which clearly distinguishes it from the carrot occurs in the time of Charlemagne, from which it gained in popularity so that it was used commonly by 1300. Tragus, the botanist, in 1552, states that it was recommended to be used with beans during Lent and another reference is to the effect that before the Reform in England it was served with dry fish during Lent.

The development of the modern type of parsnip can be traced to the 16th century. It reached its most important usage in the 17th and 18th centuries and was considered more nourishing than the carrot.

The seeds were brought to this country by the immigrants and it has always had a limited culture in the gardens. It has one advantage and that is its availability during the winter and early spring as it can remain in the ground if given only light protection. Freezing does not injure it, in fact it is considered beneficial by many persons.

The parsnip is a rather low growing plant the first year as the leaves arise directly from the root, are from 12 to 16 inches in length, much divided and of a strong green color. The second year a stem arises to the height of from 2 to 4 feet, is branched, has finer leaves and umbrella-shaped heads of small yellow flowers.
The culture is similar to that of the carrot. The preference is for a rather light but deep loam to permit the roots to penetrate without distortion or division. The seeds are drilled in rows about 18 inches apart and the plants thinned to 8 to 10 inches in the row, cultivated to control weeds, and harvested late in the fall.

The roots are from 1 to 2½ inches or more in diameter and from 6 to 8 inches in length. The skin covering is generally more or less wrinkled and tougher than on the carrot. Large roots are frequently fibrous so are undesirable for canning.

After cleaning, the roots are peeled in a centrifugal machine, using a coarse abrasive. They are then cut as desired, blanched from 6 to 8 minutes, filled into cans with a 1½ per cent brine and given an 8 minute exhaust. The thorough preheating in the blanch and exhaust aids in preventing discoloration. An acid blanch is not necessary with the parsnip though if the prepared material be held, it is advisable to keep it in a 3 per cent brine.

The cook is 240° F. for one hour for No. 10 cans and this is the most important size since its principal use is as stock for soup.

**Label Weights**

(Sp. Gr.) : 8Z Short, 7½ ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 8 ozs.

**Composition**

The composition of the parsnip as given by Wiley is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>80.34</td>
</tr>
<tr>
<td>Ash</td>
<td>1.03</td>
</tr>
<tr>
<td>Protein</td>
<td>1.35</td>
</tr>
<tr>
<td>Fiber</td>
<td>0.53</td>
</tr>
<tr>
<td>Starch, sugar</td>
<td>16.09</td>
</tr>
<tr>
<td>Fat</td>
<td>0.66</td>
</tr>
</tbody>
</table>

**PEAS**

*Pisum sativum*

The term pea is applied to several related leguminous plants having more or less twining habits and producing more or less roundish seeds in pods. This broad use of the term makes it difficult to trace the origin of the garden variety as one cannot be sure which kind is meant in the older writings. The pea, using the term to include more than one species, is ancient as far as its use and cultivation are concerned. It is believed to be native to the warmer part of Asia east of the Mediterranean, Persia, India, Egypt, and southeastern Europe. The Sanscrit origin of the name lends support to this view for while *pisum* is Latin, it has the Sanscrit root *pie*, *pis* being divided, or decomposed. The Sanscrit *pocí* designates the pea separated from the pod. The field pea, *Pisum arvense*, is native to the section just mentioned and while the garden variety *Pisum sativum* differs from it in several respects, it is believed by some botanists to have been developed from it through cultivation during many centuries or that the
two have a common parentage. Pea seeds have been found in prehistoric remains in Hungary and Switzerland that carry it back to the bronze and even to the stone age, and in tombs and sepulchers of more modern construction built 2000 or more B.C.

The field pea was a very important crop in early agriculture from Italy eastward around the Mediterranean, but the garden variety is not specifically mentioned until a comparatively late date. Columella and Palladius, writing at the beginning of the Christian Era, knew the garden pea but it evidently was not much esteemed at that time by comparison with the field pea, the lupin, and the vetch. Another big gap occurs in the history and use of this plant that is covered by the mantle of the Dark Ages, during which little is recorded concerning foods, so that when the record again becomes available, it is as a plant adapted to more northern countries, especially France. During that period the mature dry pea of the garden variety grew greatly in popular esteem and the fields were protected against depredation by drastic laws similar to those for beans and lentils. These were the crops which were raised and stored as safety measures against famine and were ranked in importance with wheat.

According to the "Cries of Paris" of the 13th century, green peas were hawked in the streets with the cry: "I have peas in pods quite fresh," and the preparation of peas in various ways is indicated a little later in the following literal translation which, of course, does not give the poetic effect of the original:

"Peas with oil and beans pounded,
Beans podded and peas scalded,
Peas hot, peas warm, and peas cold,
Peas prepared and seasoned."

Pea soup or purée, made from ripe peas, was the dole issued to the poor in the cities during a long period.

Dry peas prepared with salt pork or bacon furnished one of the favored and substantial dishes until the 16th century. It was frequently given a place of honor at great feasts as well as on the tables of modest homes.

The popularity of the succulent green peas undoubtedly reached its zenith in the 17th century. Kings, princes, all ranks of royalty, and their satellites set an example in the eating of this dish which might be characterized as gluttonous. It was the fashion so large prices were paid for peas produced out of season. It had a good effect, however, in that it stimulated gardeners to improve the strains and it is to their efforts that the modern type can be traced.

The English imported the pea from France at some period during the Middle Ages and at the time of the Norman conquest it probably led as a food crop in the southern part of the island. Peas were consumed ripe but later the vogue for eating green peas also struck the country and to such extent that they sent to Holland for supplies, whence the saying: "They came so far and cost so dear." The English gardeners likewise profited from the fad and were the first to give names to varieties which they developed—three of which were sugar peas. In 1787, they developed the sweet wrinkled strain and in 1847 a variety known as the Champion of England was brought out and is still grown. It is probably the oldest variety now listed. The English gardener has consistently led in the improve-
ment of this plant though, in the meantime, the French produced the dwarf varieties which need no support.

The Chinese usually lay claim to priority for the introduction of plants and foods of ancient lineage but in this case the plant seems to have been carried from India to that country about 1600 A.D.

The use of the pea in this country is concurrent with the earliest settlements as the seed was brought by the pioneers and planted in kitchen gardens. It is still one of the standby crops for the home and local market garden and in addition is cultivated in large tracts in the South for shipment to the early spring markets in the North and in certain sections of the North as a canning crop.

The Plant

The plant is a fairly tender annual, growing from 1½ to 5 feet in length with a vining habit but this character has been greatly modified in the low growing varieties. It is within the memory of many persons when nearly all peas had to be provided with stakes or brush, but at present the kinds used for canning crops and in most gardens are of an approximate dwarf habit and sufficiently stiff not to need support. The flowers, which are white and closely resemble the flowering sweetpea, occur singly, usually from 3 to 5, followed by a plump many-seeded pod. In the canning varieties it is important that the seeds mature at nearly the same time. These are of two types, the round with a smooth surface of which the Alaska and Little Gems are the best known and the sweet wrinkled which is flattened and has a wrinkled surface when mature, well represented by the Admiral, Advancers, Horsford's Market Garden, and Perfection, the last being a new strain. The round pea is the earlier, the more attractive in appearance, and for a long time was preferred for canning, making from about 80 to 85 per cent of the pack. Of late, however, the proportion of round peas has fallen and the sweet wrinkled have risen until they practically balance. The sweet wrinkled varieties are more irregular in maturing, and tend to become yellowish on getting old, but have the decidedly more characteristic and pleasing flavor.

Culture

The pea is grown for canning as a field crop in patches varying from a few acres to large tracts of several hundred acres. They are sown broadcast or drilled as early in the Spring as safety from hard frosts and the condition of the ground will permit. They require from 60 to 80 days to develop to the point suitable for use in the northeastern section of the country and in the West require a longer time. Preference is for a loam soil in good tilth and having a fairly uniform exposure. Hilly or rolling land conduces to irregular development, and cold, moist soil favors aphid attack. The land needs to be clean as the presence of weeds interferes with hulling. The planting is done over a period of from three to six weeks for the purpose of lengthening the harvest but the temperature during the growing period may upset any calculations made along that line. An extensive study of this phase, covering a period of twenty-five years has been made by F. A. Stare of Columbus, Wisconsin, and reported in the trade papers.
Pea growing for canning is carried on in the northern part of the eastern and central states, in one mountainous locality in Tennessee, in the high altitude of Colorado, Utah, and Idaho, and in Washington in the northwest. A line drawn from the southern boundary of Maryland running west to Illinois, and northwest into Minnesota and thence eastward will include nearly the whole of the producing area in the northern states and Canada. Wisconsin leads in production both in quantity and for high average quality. Within recent years there has been a marked drifting toward the mountainous sections for the production of peas both for canning and for seed. The largest pea cannery is now located in Utah and important seed farms are in Idaho. The object desired is to select places having a long, cool spring in which to mature a tender crop. Whether or not this movement will have permanency remains to be seen for when peas are grown in small plots or on fields of undulating contour, with irregular exposure to the sun and variation in soil, factors common in mountain farming, irregular ripening may more than counterbalance the benefits to be gained in other ways.

The time of harvesting for canning in the different states is about as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>May 1 to June 1</th>
<th>June 15 to August 15</th>
<th>June 1 to June 15</th>
<th>June 20 to July 10</th>
<th>June 5 to June 15</th>
<th>May 25 to June 10</th>
<th>June 15 to August 5</th>
<th>June 1 to June 15</th>
<th>June 15 to August 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Jersey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oregon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tennessee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utah</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While the pea has received an unusual amount of attention from seedsmen and a very long list of varieties, running into the hundreds, have been catalogued, there are probably less than a dozen with outstanding merit. There is still room for improvement in hardiness and more sturdy characteristics in the plant, in greater uniformity of maturation of pods, higher yield, and better flavor, especially in the round varieties. The pea naturally matures its pods from the bottom to the top of the vine and in producing canning strains which mature all the pods at nearly the same time some other desirable qualities have been sacrificed. The plant is subject to insect attack, particularly the aphid, and to disease.

The average yield of green peas is about 1,800 pounds per acre, the range being from 1,000 to 2,500 pounds. The apparent reduction in yield per acre of late is due to cutting earlier in order to get a higher yield of first quality. Peas which formerly produced 2,000 pounds or more are now cut to give the largest yield of fancy stock and thus return only about 1,600 pounds, or if cut to have the upper pods strictly fancy and the larger peas, extra standard yield 1,800 pounds. Or to put it in another way, where formerly the yield was near 100 cases per acre, it is now under 80 cases. Here is evidence of better canning beginning with the foundation stock.

The price paid for peas varies from 2 to 4 cents per pound, the average being 2.8 cents. The total value of the raw product is approximately $9,000,000 per annum.

An important report upon the study of canning varieties of peas is that from F. H. Hall. The following notes upon the Alaska and Advancer
varieties are reported in full and a summary made of the field data relating to them.*

Alaska Peas

"ALASKA. The standard early canning pea. Seed grayish or bluish green, or in best strains pure medium green; originally smooth or very slightly pitted or dented, but strains from the best breeders now distinctly pitted and dented, sometimes almost wrinkled. A pea of poor quality, starchy, frequently canning distinctly mealy; requires added sugar for most palates, which commercial canners usually add in processing. The canned peas are of good color, which is retained well for slow serving. Often canned ungraded but gives a good percentage of small peas, the three strains grown in Station tests showing from 4 per cent to 7 per cent of No. 1's, and from 17 per cent to 27 per cent of No. 2's. The dry seeds run about 165 seeds to the ounce, but may vary widely for different strains (from 115 to 178 in samples from different sources received at the Station in the same year). This variation in seed size may result in thick or thin sowing with drills set to sow the same quantity per acre; as in Station tests where three samples sown in the same drill with gears unchanged, produced at the rates of 562,600, 642,500, and 774,400 vines to the acre.

"The green peas ready for canning show similar, though not so great variations, the three samples referred to above running 93, 100, and 194 peas to the ounce of usable peas. Similar differences were also shown in the number of peas in the pod, averaging in the three samples, 3.41, 3.79, and 4.14 usable peas.

"The vines of the Alaska are slender, about 1 ¾ to 2 feet long, but usually standing about a foot to ½ inches high, making them easy to cut. The foliage is very fine and very light green. The vines in our tests carried about three pods, ready for the viner at practically the same time. The three samples in Station tests averaged, of usable and unusable pods respectively, 2.55 and 0.38; 2.46 and 0.32; and 2.42 and 0.32. In other words, 87 per cent to 89.8 per cent of the pods of each strain were usable at the same time."

Advancer Peas

"ADVANCER. With growers this is probably the favorite canning pea. Large vines, large, well-filled pods, large peas, and good yields make it, where sold on bulk weight basis, one of the most profitable peas to grow. For the canner, however, the percentage of large peas is too great, more than 80 per cent of the weight of the peas going to 4’s and 5’s. While a wrinkled pea, it is not of the highest quality and is rather apt to run too light in color, especially when cut rather late, as growers are often tempted to cut it because of the rapid increase in yield as the pods approach maturity. The percentage of usable pods at cutting time is as good or better than in Alaskas; the vines give about three good pods each and the pods show about 4½ peas to the pod which run about 65 to the ounce. The seeds are of a peculiar light, grayish-green color with a few cream-colored ones, averaging about 130 to the ounce. There are slight differences in strains, again due quite largely to the increased number of vines to the acre from the small seed of one strain. The differences between the strains is of more

*Hall, F. H. New York Agricultural Experiment Station, Bulletin No. 526.
financial effect where peas are sold ungraded, almost disappearing where computations are made by grades."

The following from the same bulletin is of interest, the data having been obtained from plot experiments and calculated to the acre. As in most experiments of this kind the figures are higher than under farming conditions. However, they give the relativity of the different factors.

<table>
<thead>
<tr>
<th></th>
<th>ALASKAS</th>
<th>ADVANCERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total yield per acre, pounds</td>
<td>18,085</td>
<td>30,250</td>
</tr>
<tr>
<td>Number of vines</td>
<td>659,850</td>
<td>645,500</td>
</tr>
<tr>
<td>Weight of usable pods, pounds</td>
<td>9,708</td>
<td>15,754</td>
</tr>
<tr>
<td>Weight of usable peas</td>
<td>3,837</td>
<td>7,581</td>
</tr>
<tr>
<td>Ratio of peas to pods</td>
<td>1:2.53</td>
<td>1:2.08</td>
</tr>
<tr>
<td>Number of pods per vine, good</td>
<td>2.49</td>
<td>2.87</td>
</tr>
<tr>
<td>Number of pods per vine, poor</td>
<td>.34</td>
<td>.46</td>
</tr>
<tr>
<td>Number of pods per vine, total</td>
<td>2.82</td>
<td>3.33</td>
</tr>
<tr>
<td>Number of peas per pod</td>
<td>3.78</td>
<td>4.34</td>
</tr>
<tr>
<td>Weight of peas passing 18/64 sieve</td>
<td>2.20 5.7%</td>
<td>3.8 0.5%</td>
</tr>
<tr>
<td>Weight of peas passing 20/64 sieve</td>
<td>8.35 21.7%</td>
<td>26.4 4%</td>
</tr>
<tr>
<td>Weight of peas passing 22/64 sieve</td>
<td>2.02 52.6%</td>
<td>77.2 11.5%</td>
</tr>
<tr>
<td>Weight of peas passing 24/64 sieve</td>
<td>77.5 20.0%</td>
<td>4.273 56.4%</td>
</tr>
<tr>
<td>Weight of peas passing 26/64 sieve</td>
<td>1.735 29.4%</td>
<td>492</td>
</tr>
<tr>
<td>Weight of peas above 26/64 sieve</td>
<td>167 151</td>
<td></td>
</tr>
<tr>
<td>Trash through 16/64 sieve</td>
<td>107</td>
<td>151</td>
</tr>
<tr>
<td>Number of peas per ounce, 16 sieve</td>
<td>175</td>
<td>164</td>
</tr>
<tr>
<td>Number of peas per ounce, 18 sieve</td>
<td>125</td>
<td>120</td>
</tr>
<tr>
<td>Number of peas per ounce, 20 sieve</td>
<td>91</td>
<td>88</td>
</tr>
<tr>
<td>Number of peas per ounce, 22 sieve</td>
<td>74</td>
<td>65</td>
</tr>
<tr>
<td>Number of peas per ounce, 24 sieve</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>Number of peas per ounce, 26 sieve</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>Number of peas per ounce, average</td>
<td>99</td>
<td>66</td>
</tr>
<tr>
<td>Dry peas per ounce</td>
<td>142</td>
<td>155</td>
</tr>
<tr>
<td>Weight of threshed vines, pounds</td>
<td>8,000 13,645</td>
<td></td>
</tr>
<tr>
<td>Weight of poor pods, pounds</td>
<td>476</td>
<td>836</td>
</tr>
<tr>
<td>Weight of good pods, pounds</td>
<td>5,737</td>
<td>8,035</td>
</tr>
<tr>
<td>Weight of trash, pounds</td>
<td>808</td>
<td>151</td>
</tr>
<tr>
<td>Total</td>
<td>14,328</td>
<td>22,668</td>
</tr>
</tbody>
</table>

Beginning of Canning

The green pea was one of the first vegetables to be canned and, owing to its quality, was the aristocrat among the early productions. The work of preparation was wholly by hand so that it was naturally expensive, but inherent goodness caused a greater demand for it than for other vegetables. It was also one of the early vegetables to be packed in quantity in this country, the packing having started in Baltimore in the '50s and in spite of the great amount of labor involved, in time it reached 70,000 cases annually and remained at practically that figure until the early '90s, when the "podder" and then the "viner" were perfected. Other devices as graders, washers, conveyors, and fillers followed at short intervals, and by 1910 a complete line of special machinery was available, the first in the entire canning industry. Some of the apparatus is exceedingly ingenious and performs complicated operations with remarkable ease and accuracy. In no other line of the industry is more attention paid to the appearance and niceties of the product. Mere food value is a secondary consideration as that can be obtained in equally good but less expensive form. It was the first product to be studied bacteriologically by H. L. Russell of Wisconsin, in 1895, to determine the cause of spoilage, and the first commercially
canned product to be studied by any state experiment station, by G. Harold Powell, in Delaware, in 1898.

During the early period the peas had to be grown near the large cities as it required thousands of persons for a few weeks to do the picking in the fields and the shelling at the factory, and help was not available in the smaller places. Now every operation is so nearly mechanical that it can be carried on at any place.

**Volume Canned**

The pea ranks with corn and tomatoes for first place among canned vegetables, some seasons one being ahead and in other seasons another. The average production during the past ten years has exceeded 16,000,000 cases. The range during several years is shown in the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910</td>
<td>4,374,000</td>
</tr>
<tr>
<td>1911</td>
<td>4,532,000</td>
</tr>
<tr>
<td>1912</td>
<td>7,307,000</td>
</tr>
<tr>
<td>1913</td>
<td>8,770,000</td>
</tr>
<tr>
<td>1914</td>
<td>9,347,000</td>
</tr>
<tr>
<td>1915</td>
<td>9,272,000</td>
</tr>
<tr>
<td>1916</td>
<td>6,686,000</td>
</tr>
<tr>
<td>1917</td>
<td>9,829,000</td>
</tr>
<tr>
<td>1918</td>
<td>10,898,000</td>
</tr>
<tr>
<td>1919</td>
<td>8,685,000</td>
</tr>
<tr>
<td>1920</td>
<td>12,317,000</td>
</tr>
<tr>
<td>1921</td>
<td>8,207,000</td>
</tr>
<tr>
<td>1922</td>
<td>13,042,000</td>
</tr>
<tr>
<td>1923</td>
<td>13,948,000</td>
</tr>
<tr>
<td>1924</td>
<td>19,315,000</td>
</tr>
<tr>
<td>1925</td>
<td>17,816,000</td>
</tr>
<tr>
<td>1926</td>
<td>17,709,000</td>
</tr>
<tr>
<td>1927</td>
<td>12,936,000</td>
</tr>
<tr>
<td>1928</td>
<td>17,943,000</td>
</tr>
<tr>
<td>1929</td>
<td>18,530,000</td>
</tr>
<tr>
<td>1930</td>
<td>22,035,000</td>
</tr>
<tr>
<td>1931</td>
<td>13,285,000</td>
</tr>
<tr>
<td>1932</td>
<td>10,356,000</td>
</tr>
<tr>
<td>1933</td>
<td>12,892,000</td>
</tr>
<tr>
<td>1934</td>
<td>15,741,000</td>
</tr>
<tr>
<td>1935</td>
<td>24,698,000</td>
</tr>
</tbody>
</table>

**Field Operations**

The collection of data to be used in the canning starts before the load arrives at the factory. It begins with a complete record of the time of planting, the nature of the ground on which planted and by whom, in order that the field superintendent may be informed of what to expect when harvest time arrives. There is probably no crop that has a narrower range for being in prime condition so that it requires exact knowledge of all the conditions and the closest kind of inspection to have the cutting done at just the right time. Hilly fields require harvesting in spots to prevent the more advanced vines becoming over-ripe or taking the more backward when immature. The grower can rarely be trusted to set the time as it is not often that he has sufficient experience, in addition to which he is inclined to consult his convenience. The lower pods mature first so that the cutting is done when those peas are full grown but before they begin to harden. If the top pods be immature, they are the ones to be sacrificed. To wait until the top pods are in a prime state results in a greater yield but with a high percentage of hard peas and no method now known will grade them out. The gravity system helps but makes only a partial separation. Quality is obtained at a sacrifice in quantity; that is, by cutting before the most advanced have hardened.

The harvesting is done with a mowing machine, or mowing machine with a special cutter bar and buncher attached, or in the West with a drag having two flat cutting blades projecting from the sides to cut two rows at a time on a level with the ground. The vines are bunched and loaded on wagons like hay. The cutting is done only as rapidly as the vines can be hauled away, as less change takes place in the peas while on a living vine than on
those cut. A good rule is to cut no vines in the evening unless the weather be cool, nor cut so late in the afternoon that the peas cannot be run through the factory the same day, but to start the work in the morning. "An hour from the field to the can," while nothing more than a trade catch phrase, is after all expressive of the speed necessary to tie the various steps into a continuous operation.

In order to avoid the necessity for teams standing during the unloading operation, wagons may be exchanged, or unloading slings be used for dumping and then the pitching be done from the ground upon a conveyor to feed the viner. The most recent way is to use dump trucks, a dumping platform taking the place of a gravel or dirt bed. One such truck takes the place of four teams.

Viner Stations

Formerly the shelling of the peas was all done at the factory or in a few exceptional cases there might be one viner station. The present tendency is toward a complete reversal of this procedure and to shell all peas at outside stations. This condition has been brought about by various factors, as the speed truck which can go long distances and pick up the threshed peas at short intervals; to a better appreciation of the feeding value of the vines on the farm; the desire to abolish a fermenting nuisance near the factory or in a closely inhabited district; and the economy of having a few trucks hauling the shelled peas, with little loss of time in loading and unloading, instead of dozens of wagons with their bulky loads going to the factory, and of vines returning if hauled back to the farm.

The advantages of having the viners at the factory are: more permanent construction of housing, better mechanical control and supervision of all machines, a greater output per unit with fewer operators, and immediate delivery of the shelled peas to the canning department. The advantages of viner stations are: the great saving of hauling heavy loads, short hauls, ability to cut and deliver to keep the machines at full capacity, lessened cost of stacking the vines for silage or removing them for hay, lessened cost of housing the machinery, and less capital invested in yardage. An important advantage is the ability to move the equipment to a new neighborhood where conditions may be more favorable should plant disease or other local causes make such action desirable. The advantages of each system need to be well considered for the particular place in determining which is to be adopted.

The load may or may not be weighed at the factory but it is given a general inspection and assigned to a viner operating on the same grade if possible. This is a minor detail but when a viner has been adjusted to get the maximum efficiency in the handling of a certain class of vines as long or short, a little tough, or fresh and tender, it is well not to change the speed for a different condition, at least this holds for the ordinary viner operator. At viner stations it is not customary to weigh the loads since the information obtained is only of general interest or for use in prorating vines when being hauled away. At one time a handful of vines was drawn from three or four points in the load, the pods shelled by hand and the peas tested by floating them in a salt solution of a definite strength. The percentage of peas that floated determined the grade and the amount to be paid per hundred pounds. A more nearly accurate method is based on running a sample
of the shelled peas over a trial grader which gives the percentage of the different sizes, and, since each load is fed into a machine separately, it is easy to get the number of pounds and calculate the value of each. In some plants automatic weighing machines are installed to keep the record. Each viner may have its own scale, or one scale may be used for as many as four viners by providing proper discharges from the viner boxes so that the peas fall on a common conveyor when the gates are opened.

Pea Sheller

The pea shelling machine is the invention of Madam Faure of France in 1883. It was first described in *La Nature*, Paris, April, 1885, and a translation of the article with an illustration occurred in the *Scientific American*, June 6, 1885. The translation is herewith reproduced:

"Machine for Shelling Peas"

"This curious machine, which we saw in operation at the last Agricultural Exhibition, consists of an oblong frame in which revolves a hexagonal drum. The latter, which is surrounded by wire cloth, is supported by rollers and is revolved through the intermedium of a pulley. An axle concentric with the drum carries a number of oblong pieces arranged obliquely around it, and revolves in the same direction that the drum does, but with much greater velocity. These oblong pieces or beaters pass within a short distance of rods that form the angles of the drum. Beneath the whole is stretched an endless apron that revolves continuously.

"The peas are placed upon the platform of the machine and fed by hand to the drum through a hopper at the top. They are then submitted to the action of the beaters, which open the pods and allow the peas to fall through the meshes of the wire cloth. In consequence of the oblique arrangement of the beaters, the pods continue to advance toward the extremity of the drum where they fall into a chute. The unshelled peas are caught at the upper part of the drum by the ribs that project into the interior, and are thus struck by the beaters, so that the shelling is perfect before the peas drop into the box beneath."
"The results with this machine are remarkable, and its performance is important, since it can do as much work as several hundred women in the same length of time.—La Natura."

That invention is the backbone upon which the pea canning industry is based, the means of shelling the peas by mechanical methods instead of by hand labor. Each machine now in use performs the labor of about 200 persons. Some factories use as high as twenty machines or the equivalent of the work of 4,000 persons, a number that could not be obtained or housed except at a very high cost for the short period of three or four weeks. The number of machines in this country is approximately 4,000, capable of doing the work of 800,000 persons.

There have been many patents issued upon pea shelling machines, but the basic principles of the only successful power machines are to be found in the one just described—the improvements have been in mechanical details. In May, 1888, R. Karges, of Germany, patented a machine in this country that employed the same shelling device. In August of the same year, a patent was granted to R. P. Scott for a machine similar to that invented in France. This was generally known as the "podder." In this patent reference is made to an application for a patent by C. P. Chisholm and J. A. Chisholm, but which was not granted until 1890. It appears that the Chisholm patent pertained especially to the drum and beating mechanism and the Scott patent more particularly to the vibrating canvas separator. In March, 1889, a machine, the joint efforts of R. P. Scott and J. A. Chisholm, was patented and known as the "viner." The principles of the Faure invention were employed but the machine made larger, sturdier, and with some modifications in mechanical details thus adapting it to the larger use demanded in volume production in canneries in this country. The podder soon gave way to the viner and practically ceased by 1908. That year three or four podders were in use at Green Bay, Wisconsin, and a few in Baltimore to care for the surplus peas which came from the fresh vegetable market.

These simple machines, when properly operated, leave few peas in the pods and cause little injury to those which are shelled. The viner ranks as one of the ten outstanding inventions in the industry. A viner will handle from 2½ to 3 tons of vines per hour and these yield on an average of 600 to 1,200 pounds of peas. Six viners working on average peas will keep one canning line busy on No. 2 cans (100 cans per minute) and have some margin on good peas, but eight viners are necessary for one line on poor peas. Eight men are needed for the pitching and two to look after the machines. Hand feeding has been wholly supplanted by mechanical feeders as these tear the vines apart and distribute them better as they go into the viner. Uniform pitching of small forkfuls to prevent bunching one moment and idling of the machine the next is the most important step in securing both volume of vines through the machine and clean shelling of the pods. The speed of the mechanism is kept as low as possible to obtain good shelling as it produces fewer bruises and, therefore, averts slip-skins and splits. It is not the sole cause of this trouble but an important contributory one. Old peas with the pods drawn tightly upon the seeds and those made tough by dry weather require stronger beating. On the West Coast, some of the viners are made longer than in the eastern section in order that this may be accomplished. The pods are very tough, though the
seeds are tender. A viner handles the product from about 60 acres during a season, but this is naturally subject to variation due to the length of the season and the character of the vines. A lesser average now than ten years ago is due to using peas in a less mature state and to cutting the speed of the viners to produce a finer quality free from splits.

Pea Boxes

If the peas be vined at a station and hauled to the factory, it is of the highest importance that they be handled in clean boxes, and in thin layers not over six inches in depth. If the shipping cases are of clean material with tight joints, they make good carriers for two or three trips and then are set aside for fresh ones. If reasonable care be used, they can be kept clean and free from marks so they can be sent into the trade without criticism. If special lug boxes be made, it is important that they be of dressed material and preferably painted so they can be washed after each trip and not absorb much moisture. The shelled pea becomes more or less gummy on the surface so that boxes become contaminated and require thorough washing, otherwise they become the carriers of an unlimited number of spoilage organisms. If the peas be allowed to stand and sweat or become wet for any reason, the number of organisms is greatly increased with a corresponding infection of the boxes. Routine cleaning can be done by running the boxes through sprays of water but this needs to be supplemented at times by thorough scrubbing with a brush. It must also be borne in mind that if sprayed boxes do not dry promptly, the number of organisms may be largely increased due to the moisture present. The safest treatment for infected boxes is to follow the washing with a fine spray of sodium hypochlorite, an inexpensive disinfectant, and the least objectionable of any now in use.

After the peas are shelled, the succeeding steps need to be carried out in quick succession. The pea suffers more change in three hours when shelled than in a day in the pod. It might be an exaggeration to say that they are seriously injured in that time, but each additional hour is attended by hardening, loss of flavor, and with an increased tendency to cause cloudy liquor. If for any reason it be necessary to hold peas, these should be the poorest grade and preferably in water. Water holding systems have been developed for handling all peas but it is best not to resort to such methods except in emergencies; peas carried in this way lose flavor and are rarely better than standards.

Cleaning and Washing

Following the shelling, the peas are run through a special cleaner or fanning mill to remove bits of leaves, pods, vines, and other light, extraneous material. One machine serves for six viners.

Peas always become dirty from the shelling which loosens any dirt clinging to the vines and also from contact with the conveyors so that while they may appear clean, they, nevertheless, need a thorough washing. The same operation, too, serves to remove light peas, slip skins, and thistle buds. The most popular washer for a long time and one still used is the squirrel cage, a cylinder of fairly heavy wire screen mounted on rollers set on an incline and within which is a perforated pipe to deliver a spray of water as the peas pass through. This was developed first as a cleaner after blanch-
ing and without a water supply, but someone turned in a hose and discovered it was an excellent washing machine. The perforated pipe followed with the result that the principle is more widely used and on a greater number of products than any other. The rotation of the drum causes the peas to rub against each other, and the sprays carry away any dirt. One washer suffices for one canning line.

**Removing Thistles**

If the peas contain Canada thistle buds, as frequently happens in Wisconsin and other states about the Great Lakes, they are fed into a tank of water with the result that the thistle buds float on the surface and are skimmed off while the peas sink to the bottom and are removed by a conveyor. This effective apparatus, based on the gravity grader, was first tried out at the suggestion of the writer when visiting a factory at Green Bay, Wisconsin, in 1912. The factory was congested with peas at the time due to the fact that enough pickers were not available. A tub with a light brine was first tried, the peas being dumped in and stirred and the thistle buds and some peas skimmed off the top. Next plain water was tried with even better separation. A trough was built and a wire skimmer fashioned to fit it. Ninety per cent of the thistle tops were removed in this way and the few peas that floated were discarded as not being worth the trouble to remove them. From this was constructed a thistle grader, the peas being conducted through on the regular line and the buds skimmed off. Some factories at that time employed from 50 to 200 women picking thistle tops but by the aid of this device and better cultivation of the land the number has been reduced to a very few persons.

A recent development in a washer combines the operations of the former machines and does it in less space. A hopper is provided for receiving the peas from the cleaner and leading from it is an inclined chute on the bottom of which a number of crosspieces to act as baffles are attached. Water is turned into the hopper to float the peas into the chute and over the baffles, with sprays also added to aid in the cleaning. The baffles retain any heavy earth, mud, gravel, etc. At the end of the chute the peas enter a narrow trough, are carried along by means of a spiral conveyor, light peas, thistle tops, etc., are floated off at the top and the good ones diverted into a short wire drum and sprayed. The capacity is equal to one line.

**Water**

The amount of water required for this and all other operations is probably greater than required for any other vegetable with the possible exception of spinach. The minimum amounts to 5 gallons per case, the maximum is probably about 25 gallons, and the average not far from 15 gallons. It is important that the water be potable, free from excessive hardness, iron, or any other material which will discolor or injuriously affect the quality. It is preferable that soft water be used in the blanching and also in the making of brine, even if it be necessary to soften it by treatment.

**Grading for Size**

Peas have been graded for size ever since they have been canned, in fact undue stress has been placed upon this operation since it can affect only the appearance. Flavor is better in ungraded peas or in peas with
only the largest and oldest size taken out. The very small sizes which bring
the highest prices are the poorest in this respect. Many more peas are now
offered ungraded or with fewer siftings than formerly. The combining
of Nos. 1 and 2, and 4 and 5, or in other ways, simplifies the factory
operations.

The screens for this purpose have been standardized, the No. 1, Petit
Pois, 18/64 of an inch; No. 2, Extra Sifted, 20/64 of an inch; No. 3,
Sifted, 22/64 of an inch; No. 4, Early June, 24/64 of an inch; and No. 5,
or Marrowfat, are those which pass over this screen. In the case of sweet
wrinkled peas another screen may be and generally is added, 26/64, in
which event those which pass through are Sweet Peas and those which
go over the end are No. 6 or Telephone Peas. At one time some packers
had some of the screens stamped with holes 1/64 inch larger to give a
slightly different size but this kind of odd grading has practically ceased.
The term “Marrowfat” is rapidly passing, and its place taken by “Sweet
Peas” in the sweet, wrinkled variety. It would be more fitting too, to
drop the misspelled and misapplied French term (petit pois) for the No.
1 size.

Graders

The graders are of two types, the vibrating and rotary screens. The
former occupies little space and at one time was much used. The screens
are set in frames one above the other, the largest size peas in each case go
over the screen into appropriate receptacles while the other sizes pass
through. A rapid vibration is given the screens which is a rather severe
treatment for the peas and especially for those which have to pass through
two or more screens. The capacity is somewhat limited.

The rotary screen is preferred largely because of not being so rough
in its action. It is generally from 4 to 5 feet in diameter and 30 or more
feet in length, set on rollers at a gentle incline and given an easy and com-
paratively slow motion. If speeded up, it gives the peas a whipping motion
which is injurious and may affect the clarity of the brine in the can. A
late improvement consists in depressing the circumference at three or
more points to break up the whip-like motion. Originally, the smallest
screen came first and then the others in succession. In this arrangement
all the larger sizes had to pass over the smaller screens and thus reduced
their real grading capacity. In 1906, J. H. Empson introduced a short,
separate grader which took out the large size first, and thus increased the
grading surface and also increased the capacity for accurate grading. This
scheme has been followed more or less ever since but the greatest improve-
ment in that direction took place in 1927 when the huge 60 inch screen
was replaced by three 20 inch screens divided into seven 5 foot sections.
The first section, which is in the middle of the grader, sifts out all the Nos.
1, 2, and 3 sizes which are then distributed over a three-section part for
accurate grading, while the Nos. 4 and 5 pass over the end into three sec-
tions which divide them accurately. The result is that the small sizes which
need the most time in the grader are handled gently and the 60 per cent
or more of large ones are not forced to travel over unnecessary screen
surface. The length of the large cylinder and the divided cylinder graders
are practically the same, about 35 feet, the width of the former about 6
feet, and the latter about 8 feet, the grading surface in the latter, however, is greater.

In order to get an apparatus which would occupy less floor space, the large type is built in four cylinders and nested; that is, one cylinder running inside another. Further modifications have been to build half cylinders and nest them, and also to make a battery of short cylinders and float the peas from one into another.

A single 60-inch grader or three 20-inch graders have a capacity in excess of one line.

The percentage of peas in the different siftings can be indicated only in a general way for such records as are available represent the practice in a few of the better factories and not that in a state or section of country.

### PERCENTAGE OF SIFTINGS IN PEAS

<table>
<thead>
<tr>
<th>Size</th>
<th>New York</th>
<th>Michigan</th>
<th>Wisconsin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sweet Alaskas</td>
<td>Sweet Alaskas</td>
<td>Sweet Alaskas</td>
</tr>
<tr>
<td></td>
<td>Wrinkled</td>
<td>Wrinkled</td>
<td>Wrinkled</td>
</tr>
<tr>
<td>1</td>
<td>7.2</td>
<td>6.25</td>
<td>6.6</td>
</tr>
<tr>
<td>2</td>
<td>23.3</td>
<td>12.75</td>
<td>28.8</td>
</tr>
<tr>
<td>3</td>
<td>43.5</td>
<td>33.75</td>
<td>42.9</td>
</tr>
<tr>
<td>4</td>
<td>22.5</td>
<td>24.25</td>
<td>19.8</td>
</tr>
<tr>
<td>5</td>
<td>3.5</td>
<td>8.50</td>
<td>1.9</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>25.8</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Ungraded............ 41.25
Standard............. 9.

### California Peas

<table>
<thead>
<tr>
<th>Size</th>
<th>Gravity grading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alaskas</td>
</tr>
<tr>
<td>1</td>
<td>.57</td>
</tr>
<tr>
<td>2</td>
<td>1.69</td>
</tr>
<tr>
<td>3</td>
<td>4.94</td>
</tr>
<tr>
<td>4</td>
<td>12.02</td>
</tr>
<tr>
<td>5</td>
<td>30.53</td>
</tr>
<tr>
<td>6</td>
<td>50.25</td>
</tr>
</tbody>
</table>

After the grading for size the peas are generally run over picking tables so that the workers may take out the defective material that cannot be removed mechanically. A common scheme is to have the graders elevated to a sufficient height so that the chutes lead directly to the tables. This is the only point where it is necessary to touch the peas by hand, but it is followed by blanching and washing. In the case of sweet wrinkled peas, where there is a strong tendency for the older ones to turn yellow after heating, the picking may be done to better advantage after blanching.

### Grading for Quality

The fact that the lower pods mature earlier than those at the top, that the vines on a southern exposure advance more rapidly than those on the north side, or that those checked by drought are some days ahead of those on moist ground are conditions which make it impossible to have all the peas in prime condition at the same time. Under favorable conditions the percentage of hard peas is so small that the pack can be made strictly fancy. Under unfavorable conditions, especially during or following a hot spell near harvest, the percentage of hard peas may be so great that the field
run may not be above standard grade. There are all gradations between
and when such conditions prevail, it is desirable to separate the hard peas
from the tender which can be done to a certain extent on the basis of their
specific gravity, the young tender peas being lighter than the hard starchy
ones. This principle of separating seeds was first patented by W. H. Webb,
Longmont, Colorado, in 1894, and while he indicates its use for the separa-
tion of green peas, it did not become known to others until improved and
operated by Ralph Polk in 1907. A narrow tank is provided, in the bottom
of which is a conveyor to remove the peas which sink because of their
weight and another at the top to skim off those which float. The tank is
filled with a weak brine, one testing about 1.040 on the specific gravity
scale, the peas dropped into the bath gently, and the separation made con-
tinuous as they float or sink. Those which sink can be still further sepa-
rated in a heavier brine, one testing about 1.070. While the peas which are
separated as floaters in the first bath may not be strictly fancy, they are of
good quality and the percentage thus obtained makes it possible to pack a
decidedly higher grade than without such separation. The peas which go
to the bottom in the brine testing 1.070 are only slightly better than soaked
peas, and in most cases these can be soaked for an hour or two before
canning and the quality improved, or, better still, discarded to be used as
stock feed. The results of gravity grading after separation of the sizes
is better than when grading the field run, as some differences can be made
in the adjustment of the salt solution that are more nearly in accordance
with the need for the size, and which can be determined only by experiment.
Several modifications of the grader are available but an essential to good
gravity grading is that the brine be in a state of rest, a factor not recog-
nized nor obtained in the first devices nor in some of the later ones so that
some of the criticisms directed against the method are not justified. In an
improved device not upon the market this has been taken into consideration
and the work made more nearly accurate.
One development in this form of grading is to place the gravity grader
in the line after blanching.
A difficulty with this type of separation is to keep the brine solution
constant by frequent additions of fresh solution as the brine is constantly
diluted from the water adhering to the peas as they enter the tank and by
carrying away salt as they leave. An electrical brine-o-stat has been de-
veloped to keep control, but thus far has not proven equal to a competent
attendant. Some salt is absorbed by the peas so that only one-half the usual
amount should be used in the brine for filling the cans.
The differences in specific gravity continue after the blanching and even
after cooking in the can but naturally are less marked. It is easily demon-
strated, however, by the use of salt solutions though they have to be of a
different specific gravity from that used in the first instance.
If the grading be carried to the limit for size and gravity on both Alaskas
and Sweet Wrinkled varieties a factory would have more than thirty kinds,
which is obviously uneconomical.
Blanching
The handling of the peas from the temporary storage after grading to
the blancher is now being done by water flumes. These are metal troughs
or pipes in which the peas are carried in hot water made to flow toward
the blancher by means of a pump. Baffles are placed in the bottom of the last few feet of the trough and these remove much of the surface contamination. The effect is to heat the peas more gradually, to keep the temperature in the blancher more uniform, and also to keep the water cleaner.

 Blanching is a necessary part in the canning of peas and its importance varies with their condition. The primary object is to give the peas a thorough cleaning. The peas always become contaminated with more or less dirt in the preliminary operations and from gummy substance developed on the surface due to drying of the juice and sugars from the bruised pods and vines as well as from some of the green seeds. The thin gummy layer holds the dirt and dissolution is more rapid in hot than in cold water.

 A second object is to reduce bacterial contamination which is naturally associated with shelling, and other conditions under which the peas are held. This might be regarded as one phase of the first objective.

 A third objective is to get rid of a peculiar odor and flavor that is very noticeable in unblanched peas. The odor of the unblanched pea is slightly suggestive of silage and with a raw flavor that is not pleasant. These objectionable qualities become more noticeable as the peas become older or are exposed after shelling. It naturally follows that young, tender peas in prime condition require a much shorter blanch, even as low as one or two minutes suffice, than older ones which have stood after shelling.

 A fourth objective is to get rid of gas in the tissues and thus relieve some internal pressure in the can when sterilizing.

 A fifth objective is to swell and soften the peas to get a more uniform fill of the can and texture in the product. Of these objectives, the first is the more important at present. Formerly when peas were cooked in the retort at 224° to 230° F., hard peas did not soften as much as desired within the time required for sterilization. It naturally followed that the blanch was made long, 10, 15, or even 20 minutes. Under the present methods of cooking, the softening can be accomplished by raising the temperature, though it produces darkening, a cooked flavor, and more turbidity in the liquor. Some recent experiments have been reported which deny that the softening is effected by blanching, a conclusion at variance with the experience of some good packers. The peas suffer some loss of constituents in the long blanch and the attempt is made to augment the flavor by adding a little more salt and considerably more sugar.

 L. V. Strasburger,* in reporting some results upon blanching, found the normal sugar content on drained peas after blanching as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Temperature</th>
<th>Sugar Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 22, 1932</td>
<td>4 minutes</td>
<td>180 degrees</td>
<td>1.00%</td>
</tr>
<tr>
<td></td>
<td>10 minutes</td>
<td>180 degrees</td>
<td>.87%</td>
</tr>
<tr>
<td></td>
<td>10 minutes</td>
<td>210 degrees</td>
<td>.76%</td>
</tr>
<tr>
<td>June 1, 1932</td>
<td>4 minutes</td>
<td>180 degrees</td>
<td>1.10%</td>
</tr>
<tr>
<td></td>
<td>4 minutes</td>
<td>200 degrees</td>
<td>.87%</td>
</tr>
<tr>
<td></td>
<td>10 minutes</td>
<td>180 degrees</td>
<td>1.06%</td>
</tr>
<tr>
<td></td>
<td>10 minutes</td>
<td>190 degrees</td>
<td>.89%</td>
</tr>
<tr>
<td></td>
<td>10 minutes</td>
<td>200 degrees</td>
<td>.82%</td>
</tr>
</tbody>
</table>

Steam blanching has been suggested as a means of conserving certain constituents which are lost when hot water is used but appearance and

*"The Canning Trade," January 30, 1933.
flavor are of more importance in this product than the slight conservation which may be effected in this way. Further experiments are needed along this line.

The older method of blanching was to put the peas in wire or perforated cages and suspend them in a tank of boiling water until they felt soft but would not mash upon moderate pressure between the thumb and finger, or for a predetermined time. Blanching on a time schedule lends itself to mechanical means, so long tanks were made provided with a slow moving conveyor either at the bottom or an overhead trolley with long hooks for suspending the basket. Marks are made along the tank where the baskets might be set to take 1, 2, 3, 4, or other number of minutes to pass to the end and emerge. The tank and basket system is satisfactory in the hands of a good cook who gives undivided attention to the work and depends upon testing when the peas are taken out. There are serious drawbacks, however, one of which is that unless the peas are stirred at short intervals, it is almost inevitable that all will not be treated uniformly, the outer layers in the basket being subjected to more heating than those in the center. In a device made to overcome this defect, a mechanical stirrer gives a constant and gentle agitation. The other drawback is that the volume of water required is large and not changed as frequently as it should be.

The type of blancher almost universally used is the perforated drum with an inside spiral to advance the peas from one end to the other. The drum is set in a tank of water and rotated at a speed that carries the peas through in a given time, the variation in time being made by changing the speed. The volume of water is not large so dependence is placed on constantly adding water and steam to float off the substances removed from the peas. The entrance of water and steam at the pea discharge end of the blancher insures that the peas are treated with the cleanest and hottest water at the end of the cooking. The water in the blancher is ordinarily held at from 200° to 205° F. at the delivery end and from 10° to 15° lower at the entrance.

In one style, the Plummer Blancher, developed in 1900, the machine was divided into three compartments with steam control over each, the water entering the delivery end with the overflow at the opposite end. This got rid of about two-thirds of the gummy substances and dirt in the first tank and left the other two much cleaner. The fact that the different sections had a separate steam supply also gave a control not obtainable in the single compartment type. The objection to this blancher was that it lacked capacity and where volume counts first in lowering the costs of packing, it was gradually forced out.

One difficulty with all blanchers of this general type is that of cleaning. The slimy material becomes cooked on the drum and is difficult to remove, especially as there is no way of reaching the inside. The use of 75 to 100 pounds of clean coarse gravel run through the machine once or twice a day and the vigorous application of brushes to the outside of the drum is as efficient as anything yet devised. The use of the hot water flume conveyor is also a great aid in keeping this piece of machinery clean.

In tender stock handled quickly, the Blanch from 1½ to 2 minutes for Nos. 1 and 2, and from 3 to 4 minutes for the larger sizes amounts to a hot water wash to remove any adherent dirt, and to heat just enough to
get rid of the peculiar raw odor and flavor, also to act in a measure as an exhaust in getting rid of gases from the tissues. With tender peas there is practically no gain or loss of weight in blanching but there is a small percentage increase in size so they will not pass through the same screen used in the original grading. Experiments made to determine this point, using 25 pound batches, showed the weights after blanching not varying more than half a pound or within the error which might arise from the difference produced by adherence of water to the surface. Older peas requiring a longer blanch increase in size but only slightly in weight within the time usually given for this operation, but continue to increase both in size and weight during the cook in the can. This is in agreement with the observations in daily practice that with very young peas the fill in the can will be very nearly that required in the cut-out, while with older peas it will be less, and in a low grade it may be only 11 ounces for a No. 2 can.

In an experiment in which the peas were divided into three grades by the specific gravity method and each grade blanched 10 minutes to keep that factor uniform, the results were as follows:

<table>
<thead>
<tr>
<th>Size of pea</th>
<th>1st grade</th>
<th>2nd grade</th>
<th>3rd grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28%</td>
<td>45%</td>
<td>82%</td>
</tr>
<tr>
<td>3</td>
<td>26%</td>
<td>42%</td>
<td>56%</td>
</tr>
<tr>
<td>5</td>
<td>24%</td>
<td>42%</td>
<td>68%</td>
</tr>
</tbody>
</table>

When the peas were run over the same screens before and after blanching, some of them, particularly those in the third grade, had increased two sizes.

Blanching is generally done in water near the boiling point, but only as a matter of custom as with all the experimental work which has been done upon peas, it is not clear that this is either necessary or desirable. If one wishes to break the skin on a tomato, it is plunged directly into very hot or boiling water for a very short time then chilled with a cold water spray. The excessive heat causes rupturing of the surface cells through expansion of the contents so that the skin loosens from the tissues beneath and further contraction is produced by the chilling. The skin on the pea is not exactly the same as that on the tomato but there is a fairly close analogy. It is possible that the changes in temperature are too sudden and also that higher temperatures are used than are necessary to get the best results. The cleaning can be done with the water as low as 160° F.

In experiments in which blanching was done at from 180° to 185° F., the per cent of split skins in the No. 4 size varied from 4 to 9, the average being 7, while similar lots blanched from 208° to 212° for like periods showed an average of 15 per cent of loose skins. The effect upon the No. 5 size was almost the same and on the No. 3 size it was higher. A repetition of the experiment on the West Coast gave like results.

Nearly all factory superintendents believe that the splits which develop in the blanching are due to injuries to the skin received in the viner, but in experiments using hand-shelled peas there was clear evidence that a considerable percentage may arise from the severe action of the sudden changes in temperature.
Since starchiness in the liquor is closely related to the number of broken skins, this phase affords an opportunity for experimental work. No doubt some of the effects desired can be obtained at a lower temperature and by less sudden change in temperature, but at what points and with what effect upon flavor remains to be determined.

H. R. Smith, National Canners Association, has shown that turbidity is dependent upon the condition of the starch grains, and that these are affected by the moisture conditions during the growing season. If the water level be low, that is, the ground be dry, there is a much greater tendency to form cloudy liquor.

C. A. Magoon and C. W. Culpepper have given considerable attention to the effect of blanching on peas and came to the following conclusions:*  
"From a consideration of the foregoing experimental findings, it appears that some form of preliminary scalding is desirable in the canning of peas. Scalding is necessary when the canning is to be done in tin, because of the strain on the cans from internal pressure and the low vacuum obtained with material not scalded; but it is not essential in home canning in glass.

"Scalding in water results in considerable loss of valuable nutrients from the peas into the scalding water. Treatment with live steam effects the desired shrinkage, makes possible the retention of the sugars and other water-soluble constituents, and yields a satisfactory product. Scalding in water is of value for cleaning purposes, but should not be practiced if it can be avoided.

"Scalding appears to be of no particular value for bringing about softness in the finished product. Scalding with hard water may actually make the peas harder, because the formation of relatively insoluble compounds of the pectic substances with the alkaline earths.

"Mucilaginous or sticky substances are not normally present upon fresh green peas.

"Scalding does not result in a better colored canned product, and does not produce a clearer liquor when fresh green peas are used.

"The effect of scalding on taste and flavor is desirable or not, according to the personal preferences of the consumer. Scalded peas canned in tin have less flavor than those which are untreated, but the differences are not important in glass."

The water used in blanching and also in the making of brine needs to be soft and if not naturally soft, then should be made so by appropriate treatment. This has been understood in household practice for a long time. One of the earliest cookbooks published in this country, has this admonition:†  
"When your green peas have become old and yellow, they may be made tender and green by sprinkling in a pinch or two of pearlash while they are boiling. Pearlash has the same effect upon all summer vegetables, rendered tough by being too old. If your well water is very hard, it is always an advantage to use a little pearlash in cooking."

Duckwall, in 1908, when writing upon water used in canning and particularly that used for making brine, called attention to the fact that New York canners were aware of the bad effects of hard water in blanching peas.

---

†The Frugal Housewife. 1772.
and beans and that better results followed the installation of softening systems.

After two years investigation of this subject, W. D. Bigelow in *The Canning Trade* of January 31, 1916, concludes his paper with the following paragraph: “We feel that we are justified, however, in stating without reservation that hard water does not have the property of toughening canned vegetables.”

In the same journal of December 27, Mr. Huenink states from his experiments: “In conclusion, the results may be briefly stated as follows:

1. For canning baked beans a hard water is objectionable, while a water containing alkali carbonates may be advantageously used.

2. For canning peas, a water containing alkali is apt to cause cloudy liquor. A hard water is not objectionable for young tender peas, but is objectionable when used on dry ripe peas.” Mr. Huenink had first demonstrated the bad effect of hard water on dry beans the year previous.

At the National Canners’ Convention in 1928, E. E. Stevenson, of the association laboratory, opens his summary with the following statement: “The use of hard water in blanching and brining has a toughening effect on the peas. In blanching, as generally carried out, the effect on the bulk of the peas is not marked and varies because of differing conditions. The use of hard water in blanching tends to produce a non-uniform product. The effect in general depends on the hardness of the water, its rate of flow into the blancher, the time of blanch, and the relative amount of peas and water passing through the blancher.”

“In brining, the toughening effect on the peas is roughly proportional to the hardness of the water and a hardness of 150 was found to produce a distinctly perceptible hardness in number three Alaska Peas.

“The effect on the more mature peas was more marked than on the younger peas.

“The use of softened water in blanching and brining will improve the quality of canned peas.”

P. L. Gowan, in a paper on “Blanching of Peas” before the National Canners’ Convention in 1929, gave the following upon the addition of sodium bicarbonate to the blanch water. It is probably the first experiment of its kind conducted under commercial factory conditions:

“Our observation was that the addition of 1 lb. of soda per 100 gallons of water in the blancher had a favorable effect on the flavor of the peas that had been held for some time after vining. This amount was found to have little, if any, effect on the flavor of peas canned without delay. One pound of soda per 100 gallons of water does not appear to soften the peas noticeably. Three pounds per 100 gallons were found to have a slight softening effect on the peas, and it was felt that the flavor was affected favorably with peas that had been held in the boxes after vining. However, in nearly every trial, this amount produced a cloudiness in the liquor that would be objectionable. Five pounds or more soda per 100 gallons softened the peas so that they tended to become mushy in the can and at a blanching temperature of 205-212 many of the peas went to pieces during the blanch. These larger amounts of soda also tended to cause discoloration of the brine, and, in some cases, the peas. Sodium bicarbonate neutralizes acidity
and hence its addition tends to lower the hydrogen-ion concentration of the canned product and for that reason may have some effect on the process required. The samples blanched in 1 lb. and 3 lbs. of soda per 100 gallons of water showed a decrease in hydrogen-ion concentration of 0.1 and 0.2 respectively. These amounts in the finished canned product are within the natural variation of canned peas, blanched without the addition of soda. Whether this is true during the entire process, we do not know and this point should be investigated.

"The direct addition of sodium bicarbonate to the brine was also tried. The use of 0.25 per cent which was found to have a noticeable effect on the canned product, was found to decrease the hydrogen-ion concentration during the process to such an extent that an increase in the process might be necessary. It was also found that the use of soda in the brine caused such pressure inside the can during the process that badly buckled cans resulted in many cases."

At the completion of the blanching operation, the peas need to be well washed with cold water to get rid of any adherent scum and to put them into the best condition for filling into cans. This is often done with the squirrel cage washer as a large percentage of the pea hulls released in blanching will be washed out. In a more recent development the peas are discharged into a fan-cleaner and washer to blow out the loose hulls and to float off the splits and light seeds. Filling the peas into the can without chilling results in a less attractive product due to the peas settling together.

At some factories the hand picking tables follow the washer after the blanching as it permits taking out the peas which are off color and which are made more apparent by the heating. This applies particularly to the sweet wrinkled varieties.

**Filling**

The peas are filled into cans by machines especially designed for the purpose. The peas first drop into pockets which can be adjusted to a definite measure. The effort is to have the peas in No. 2 and smaller cans filled to within 3⁄8 of an inch of the top and covered with brine in the finished product. The exact fill can be determined only by trial and depends upon the condition of the peas and the treatment which they have received. In the very succulent peas, the fill may slightly exceed the weight demanded as a minimum in the cut-out while in very hard ones the fill may be as much as 12 to 15 per cent below the cut-out weight. Peas of the same variety and which appear to be the same on the vines may change enough in a couple of days to require a difference of a half ounce in the filling to give the same cut-out weight, so that constant sampling is necessary to regulate this factor. One essential in the filling machine is that it be so constructed as not to cut the peas in measuring. A filling machine has capacity for one line but owing to the number of sizes of peas it is better to use two.

**Brine**

The brine used on peas is composed of water, salt, and sugar with considerable variation in the proportions of the latter, the salt varying from 2 to 20 pounds and the sugar from 0 to 40 pounds per 100 gallons of water. Both are needed, the salt to prevent a flatness in the flavor and the sugar to
make up for the dilution due to the water added in canning. At the time of
the War, a careful note was made concerning all the lots submitted for
purchase by the Army and from the data obtained the best flavored peas
were those containing from 10 to 12 pounds of salt per 100 gallons of water.
The peas were not flat tasting nor was there a distinct flavor of salt so that
for those who preferred more, it could easily be added at the time of con-
sumption. The sugar content has always been subject to much greater vari-
ation than the salt, the New York packers especially using it with a lavish
hand. Too much sugar is as much of a detriment to the pea flavor as too
little, the former masking the peas with sweetness, and the latter causing
insipidity from the leaching of the normal sugar into the liquor. In this
same study it was found that about two parts of sugar to one of salt or
from 20 to 25 pounds of sugar per 100 gallons of water was probably best
for general purposes. Alaska peas need more sugar than the sweet wrinkled,
and old peas need an extra allowance to cover the starchy taste. The pack-
ing of peas without sugar is not to be recommended.

The making of brine should not be carried out in a perfunctory manner
but by careful measurement of the water and sugar, and by boiling, mixing,
and straining through fine cloth to remove any scum, bits of lint from the
bag, or other extraneous substances. It needs to be added without overflow
as it represents not only the value of the salt and sugar, but also the labor
of preparation. In some places it is still wasted as though it were free.

The brine is added hot and dependence placed upon it to take the place
of the exhaust. A safer method, however, is to give a short exhaust in
addition so as to insure uniformity in the product upon going into the
cooker.

Duckwall, from his observations upon operations at many factories in
all sections of the country, ever emphasized the importance of a soft water
free from all impurities, especially iron, in the making of brine. In The
Canner, March 5, 1908, is the following: “If there is iron present it will
form a brown precipitate on boiling, and if used in the canned goods this
brown precipitate will in many cases injure the appearance. *** Lime,
if present in the water to be used on succulent vegetables, makes them
tough and gives them a rather disagreeable flavor, therefore, it should be
removed. *** Much of the salt used contains lime, and this is objection-
able: then again, common salt may contain 15 to 20 per cent moisture, so
that it may be more expensive in the end than a pure, refined salt which
will test 98 to 99 per cent sodium chloride.” And in April 1, 1909, in the
same paper: “A second consideration mentioned for water to be used for
preparing brine is also very important. Most packers are undoubtedly
more or less acquainted with the difficulty in cooking such vegetables as
peas and beans tender in hard water. Other vegetables may not show the
effect of hard water on cooking to the same extent that the peas and beans
will but all vegetables do not cook up as tender as they should when cooked
in hard water, due to the fact that the salts of calcium and magnesium, to
which the hardness of the water is due, unite with the pectinous bodies in
the vegetables to form insoluble pectates, giving the hard character ob-
served in vegetables cooked in hard water.” (A view which has since been
confirmed by Magoon and Culpepper in a quotation already cited.) “A
water that may be quite satisfactory for washing, blanching, and other pur-
poses may be quite objectionable for use if employed for making brine
without treatment. It may not in every case be possible to state to what extent vegetables are affected by hardness of the water in which they are cooked, but where the water is very hard a notable difference can be observed in tenderness, and it is safe to say that the tenderness of the vegetables always depends, to an appreciable extent, upon the freedom of brine from calcium and magnesium salts."

The opposite view of the iron question as it may affect brine is given by W. D. Bigelow as follows: *"As a matter of fact, iron in the water is one of the least things with which canners have to contend. The amount of iron in any water a canner is likely to use is insignificant compared with the amount of iron taken up by most foods from plain (unlacquered) tin cans."

Cooking

The cook used for the sterilization of peas has been arrived at through long experience, many factory trials, and by laboratory experiments. Seemingly about all the possible combinations for time and temperature, varying from 212° for 3 hours to 262° for 9 minutes, have been tried at some time. The pea in the pod is normally sterile but in the process of shelling and handling and in spite of all the washing and blanching, it goes into the can laden with resistant organisms, principally the kinds obtained from the soil. The sugar content and low acidity afford ideal conditions for growth as far as the food materials are concerned and a lighter cook than for corn suffices only for the reason that heat conduction in the can is better.

The packing of peas began early when the water bath was used as the means for sterilizing everything; it was classed among the difficult products to keep and placed in the group of those to be cooked in a salt brine when that came into vogue. When calcium chloride was introduced to take the place of plain brine because a still higher temperature might be obtained, a change was again made to take advantage of any effect which might be produced. It is claimed that the pea was the first product to be cooked in the calcium chloride bath when the system was introduced in Baltimore; it was also one of the first to be cooked in the retort. Up to 1895, the cooking temperature had been held at or below 230° F., the preference being for 224° to 226°. It was considered that to go above 230° injured the appearance and flavor of the peas, and, as no one knew the cause of the spoilage, the limit in temperature was set by the apparent effect upon the pea. In that year, Dr. H. L. Russell of the University of Wisconsin was called to Manitowoc, Wisconsin, to see a serious case of spoilage occurring during the packing season. He determined the spoilage to be due to bacteria from lack of sterilization and recommended raising the temperature to 242° and to hold it for 15 minutes, which was done reluctantly but with the result that no further spoilage occurred, and neither were the peas injured. A number of persons have since worked along the same line especially with the idea of insuring safety against botulism, and the cook generally recommended for No. 1 and No. 2 cans was 240° for 40 minutes and for No. 10 cans, the same temperature for 50 minutes. An alternative provided using 245° for No. 1 and No. 2 cans for 30 minutes and for No. 10 cans for 45 minutes; or 250° for No. 1 and No. 2 for 20 minutes. This was certainly liberal enough to care for the most gross carelessness that might occur in any factory. The writer has never seen packing that required a cook of

more than 240° for 30 minutes for a No. 2 can and then with a good margin for safety. A few packers of exceptionally good quality peas have used 230° to 235° for 25 minutes, but this is too near the danger line, though it indicates that with the right kind of control it is not necessary to cook peas until they are brown, soften them until they are ready for soup, or have a flavor of overcooking in order to have them keep. Cooking above 230° does injure both appearance and flavor, but since we have become accustomed to it, it is accepted as normal. The cooking time and temperature suggested in National Canners Association Bulletin 26-L revised June, 1931, is as follows: “No. 2 can, 35 minutes at 240°, 25 minutes at 245°, and 18 minutes at 250°.” This is a reduction in time over the previous recommendation.

The French cook their peas at from 234° to 240° F., for 30 minutes for liter cans, likewise those of smaller size as a precaution and not as a matter of necessity. The German schedule is even less, 240° F. for 10 minutes, plus 6 minutes for bringing up the temperature and 6 to drop it. Fifteen minutes are allowed for the large peas, Nos. 4 and 5.

It was assumed when agitating cooking was first found to be advantageous on certain products that it would have little benefit in the cooking of peas since the water can circulate fairly free between the individual seeds and furthermore that the rolling might tend to produce a cloudy liquor. In 1920, W. D. Bigelow, in a paper on “The Processing of Peas” before the Canners Convention, gave the following upon this point:

“Peas are usually processed at a temperature of 240°. With No. 2 cans about five minutes are allowed for the retort to reach that temperature and about five minutes later the center of the can reaches retort temperature. No. 10 cans of peas are also processed at 240°, but from eight to ten minutes is often allowed for the retort to reach that temperature, and the center of the can reaches retort temperature about ten minutes later.

“The rotation of the can during processing has little influence on the heat penetration of canned peas. It is only when the speed of rotation reaches fifty or sixty revolutions per minute that the time necessary for retort temperature to reach the center of the can is materially reduced. Even then from three to five minutes are necessary for the retort temperature to reach the center of the can. It is obvious, therefore, that the use of a rotating cooker with peas will have little influence in shortening the time of processing.”

As it has worked out in practice, however, the time of cooking in a continuous agitating cooker is reduced to 20 minutes or less at 240°, to from 11 to 17 minutes at 260°, and the rotation of the can upon its axis is made to correspond to that of the reel, or only 2 to 2½ times per minute. There has been no trouble with sterilization at even shorter periods but the peas were not cooked sufficiently.

When peas are held in the cut vines over night or carried in boxes for several hours during hot weather, it has been the general rule to increase the time in the retort as a matter of safety. There is an increase in the bacterial flora under these conditions and experience indicates that some additional heating is an insurance against spoilage. The cook recommended, however, should be ample without making any changes.

Since the appearance of the finished product plays such a prominent
part in setting the commercial value, there are considerations in the matter of cooking other than sterilization. The liquor surrounding the peas ought to be clear or have but little cloudiness, and the peas be uniformly colored with a bright skin, not brown or dull looking. The presence of a layer of starch at the bottom of the can is looked upon as evidence of age or bad handling and thus a mark of inferiority. In the old method of canning with water in the retorts the appearance was generally better than when steam was used and many packers believed that water prevented the so-called “burning.” The difference in reality was due to the more gradual heating during the ten or twelve minutes required for bringing up the temperature. The same thing can be done with steam if time be given in bringing up the retort gradually and uniformly or instead of turning on a full head of steam at once with a wide open vent and then closing down suddenly. It is not speed alone but the uniformity of the heating that counts as easily demonstrated in the continuous type of cooker. In that case the can goes directly into the retort at 240° or whatever temperature is used, but as the can turns, the heat is transmitted immediately to the center and continues to do so from all points. None of the peas remain against the side of the can for sufficient time to be overheated.

In an experiment with No. 3 and No. 4 peas which had just passed their prime condition, both cooked in steam at 240° for 40 minutes, one heated as rapidly as possible in the retort, taking 3½ minutes to bring up the temperature and the other heated gradually, taking 11 minutes, but keeping the other factors the same, there was between 40 and 45 per cent more precipitate in the liquor in the former than in the latter. Some packers vary the cook with the size of the pea but upon this point there seems to be no necessity as far as sterilization is concerned and the practice may have been developed for the softening effect. Where that is followed, about one minute is added for each size number above No. 1.

Cooling

Cooling of peas should be done promptly and to atmospheric temperature. The general practice is to open the retort vent to its full capacity, open the retort door or cover and remove the peas to a cooling tank with a conveyor or trolley to carry them from one end to the other. When this system is used, the cold water should enter at the discharge end and the overflow be about ten feet from the entrance end. This insures that the cans will be dropped into the warmest water and thus not subjected to unnecessary strain by too sudden chilling. When cans are cooled in the retort, it is better that the cold water enter at the bottom so that the cans will be struck first on the filled end. The hot water always rises to the top and is the first to escape by the overflow. Spraying from above introduces cold water upon the top end of the can and with steam in the headspace, it is condensed instantly, resulting in severe strain. Without doubt thousands upon thousands of unnecessary leaks have been caused in this way.

In the continuous cooker and cooler, the cans go directly into the cooler under pressure, entering the end opposite the water inlet and the can is submerged on its side at a point where the water is the warmest in the tank. They therefore receive no sudden shock and the continuous motion contributes to the rapid elimination of the heat. Credit for introducing the practice of cooling peas belongs to the Baltimore packers, and was started
in the eighties. When the podder and viner were introduced, cloudiness was greatly increased, and R. P. Scott became the sponsor for the cooling system throughout the country. It was the first line in which it became adopted generally. Prof. Prescott and W. L. Underwood advocated cooling as a means for preventing spoilage in the first paper they presented on pea canning before the Atlantic States Packers Association in 1901. It is a most important factor in preventing cloudy liquor in prime peas and lessening the amount of cloudiness in standards. The effect upon color is also favorable in that it conserves brightness and prevents the dull browning that is associated with prolonged high temperature. It is the most important preventive of flat sours.

Effect of Cooking

While the temperature and time factors in cooking are always related in their effects upon the peas so that one cannot say unconditionally that certain results are produced by the degree of heat and others by the time element, it is possible to generalize as follows: that softening and a cooked flavor are most closely associated with the temperature employed and that discoloration, cloudy liquor, and starchy deposit are markedly influenced by the length of time the peas are kept hot.

The effect of the length of time in cooking on the liquor taken up by standard peas is shown in the following experiment. All No. 2 cans of the same lot received the same quantity of peas and brine and the weight of the drained brine after each process is given in grams thus showing the amount of liquid taken up by the peas due to prolonged cooking.

<table>
<thead>
<tr>
<th>Size of peas</th>
<th>Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>155</td>
</tr>
<tr>
<td>2</td>
<td>155</td>
</tr>
<tr>
<td>3</td>
<td>215</td>
</tr>
<tr>
<td>5</td>
<td>215</td>
</tr>
</tbody>
</table>

EFFECT OF COOKING ON THE SIZE OF DIFFERENT GRADES OF PEAS

<table>
<thead>
<tr>
<th>No.</th>
<th>Grade</th>
<th>Peas Grams</th>
<th>Brine Grams</th>
<th>Peas unchanged</th>
<th>Peas increased</th>
<th>Condition of peas</th>
<th>Character of brine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First</td>
<td>360</td>
<td>230</td>
<td>215</td>
<td>145</td>
<td>Fine</td>
<td>Clear</td>
</tr>
<tr>
<td>1</td>
<td>Second</td>
<td>385</td>
<td>205</td>
<td>150</td>
<td>210</td>
<td>Fair</td>
<td>Cloudy</td>
</tr>
<tr>
<td>1</td>
<td>Third</td>
<td>420</td>
<td>155</td>
<td>120</td>
<td>300</td>
<td>Poor</td>
<td>Starchy</td>
</tr>
<tr>
<td>2</td>
<td>First</td>
<td>375</td>
<td>215</td>
<td>320</td>
<td>55</td>
<td>Clean</td>
<td>Clear</td>
</tr>
<tr>
<td>2</td>
<td>Second</td>
<td>385</td>
<td>205</td>
<td>115</td>
<td>270</td>
<td>Sticky</td>
<td>Cloudy</td>
</tr>
<tr>
<td>2</td>
<td>Third</td>
<td>420</td>
<td>160</td>
<td>115</td>
<td>305</td>
<td>Dark, poor</td>
<td>Thick</td>
</tr>
<tr>
<td>3</td>
<td>First</td>
<td>390</td>
<td>200</td>
<td>335</td>
<td>55</td>
<td>Clean</td>
<td>Clear</td>
</tr>
<tr>
<td>3</td>
<td>Second</td>
<td>395</td>
<td>195</td>
<td>205</td>
<td>190</td>
<td>Poor, cloudy</td>
<td>Cloudy</td>
</tr>
<tr>
<td>3</td>
<td>Third</td>
<td>410</td>
<td>165</td>
<td>185</td>
<td>225</td>
<td>Sticky</td>
<td>Starchy</td>
</tr>
<tr>
<td>4</td>
<td>First</td>
<td>385</td>
<td>295</td>
<td>205</td>
<td>90</td>
<td>Clean</td>
<td>Clear</td>
</tr>
<tr>
<td>4</td>
<td>Second</td>
<td>395</td>
<td>185</td>
<td>275</td>
<td>120</td>
<td>Sticky</td>
<td>Thick</td>
</tr>
<tr>
<td>4</td>
<td>Third</td>
<td>400</td>
<td>175</td>
<td>170</td>
<td>230</td>
<td>Adherent</td>
<td>Starchy</td>
</tr>
<tr>
<td>5</td>
<td>First</td>
<td>375</td>
<td>205</td>
<td>205</td>
<td>205</td>
<td>Good</td>
<td>Clear</td>
</tr>
<tr>
<td>5</td>
<td>Second</td>
<td>380</td>
<td>200</td>
<td>185</td>
<td>200</td>
<td>Poor</td>
<td>Fair</td>
</tr>
<tr>
<td>5</td>
<td>Third</td>
<td>380</td>
<td>185</td>
<td>200</td>
<td>200</td>
<td>Very poor</td>
<td>Starchy</td>
</tr>
</tbody>
</table>

The effect of cooking on the different sizes and grades of peas was found to be as shown in the foregoing table. Gravity graded Alaska peas were used and while the results are not applicable to fancy stock, they do give striking evidence of why the factory superintendent should exercise every
effort to get the raw material from the field in the very best condition. No effort made after the vines are once cut compensates for letting the peas become too old, nor can dependence be placed upon sizing and gravity separation for more than a partial separation of the stock.

The experiment simply confirms in concrete terms what every superintendent learns in a general way that the more mature the pea, the more moisture will be taken up in the cooking in the can if the other treatment of the peas be the same. To get practically the same cut-out the ratio of peas to brine must be changed with the grade or the correction be made by a long preliminary blanch on the lower grades. The effort is to so fill the can with peas and brine that the finished product will not be less than 13.5 ounces (383 grams) of peas after draining from a No. 2 can and the liquor be sufficient to cover. On fancy peas it will be found that this weight is more than it should be for the best results.

In the grading of No. 1 peas, and to a certain extent of No. 2, there is always a quantity of tender broken peas not permitted to go into the cans; also a quantity of skinned split peas from the larger sizes and both of these are packed together in No. 10 cans for making green pea purée. When the can is opened, the peas are worked through a fine sieve and are then ready for appropriate additions and seasoning. The cans most used are the plain Nos. 2 and 1, for family use, and the No. 10 for hotels and restaurants.

UNITED STATES STANDARDS FOR GRADES OF CANNED PEAS
(Approved January 16, 1933)

DEFINITION
Canned peas are the canned vegetable prepared from the seed of the common or garden pea \((Pisum sativum)\) by shelling, winnowing, and thorough washing, with or without grading as to size, with or without precooking (blanching), and by the addition, before sterilization, of the necessary quantity of potable water, with or without salt and sugar, packed in hermetically sealed containers, and sterilized by heat.

TYPES OF CANNED PEAS

**Early peas** are peas of early maturing types.

**Sugar peas** (sweet peas) are peas of later maturing types and/or having a natural sweet flavor.

GRADES OF CANNED PEAS

**U. S. Grade A** (fancy) canned peas are prepared from fresh, young, very tender peas of the same type; are uniform in color and, unless declared to be ungraded for size, are uniform in size. They are surrounded by practically clear liquor; are practically free from skins, broken peas, and other defects; possess the typical fresh flavor of succulent, immature peas; and score not less than 90 points when scored according to the scoring system outlined herein.

**U. S. Grade B** (extra standard or choice) canned peas are prepared from fresh peas of the same type, which are tender; are practically uniform in color and, unless declared to be ungraded for size, are practically uniform in size. They are surrounded by reasonably clear liquor; are reasonably free from skins, broken peas, and other defects; possess a fresh pea flavor; and score not less than 75 points and need not score more than 89 points when scored according to the scoring system outlined herein.

**U. S. Grade C** (standard) canned peas are prepared from fresh peas of the same type, which are reasonably tender; are reasonably uniform in color and, unless declared

---

1 The pea seed is considered unbroken if the two cotyledons are still held together by the skin even though the cotyledons may be cracked or partly crushed, or the skin split. Each major portion of a skin or cotyledon not included in the above definition is considered as a broken pea.
clared to be ungraded for size, are reasonably uniform in size. They are surrounded by liquor which may be roily; are reasonably free from skins, broken peas, and other defects; possess a good pea flavor; and score not less than 60 points and need not score more than 74 points when scored according to the scoring system outlined herein.

Off-Grade Quality (substandard) canned peas are canned peas which fail to meet the requirements of the foregoing grades, or, when any one of the grading factors, with the exception of uniformity of size and color, falls in the subdivision D, or, canned peas that fall below the standard promulgated under the terms of section 8, paragraph 5, of the Food and Drugs Act.

*Note.*—Certificates of grade issued under the United States Warehouse Act or the Farm Products Grading Law covering canned peas falling below the standard promulgated under the terms of section 8, paragraph 5, of the Food and Drugs Act, must bear the legend required under that act in the space for "Remarks."

PREREQUISITES TO GRADING

**Condition of Container**

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents, and the ends shall be flat or concave.

**Condition of Package and Label**

If cased, the canned peas shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Food and Drugs Act.

**Fill of Container**

Cans of peas will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium (added liquid) is not in excess of the quantity necessary for proper processing. Head space measurement of so-called "vacuum pack" peas is accomplished by measuring from the top of the double seam to the top of the product after pouring the contents from the container (breaking apart lumps if necessary), pouring them back, and leveling the surface as well as possible without moving the container or pressing downward on the contents.

A certificate of grade covering canned peas that do not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

**Relation of Peas to Packing Medium**

Added liquid is excessive in canned peas when the proportion of free liquid in the product is such that, when the contents of the container are poured out and poured back into the container standing on a level surface, and the peas leveled without downward pressure, the liquid completely covers the peas.

A certificate of grade covering canned peas in which the above condition is found, whether or not the head space is excessive, shall bear at least the 2-line legend,

"Below U. S. Standard—Slack Fill"
"Contains Excess Added Liquid"

The maximum head space allowable in the sizes commonly used in packing peas is shown in the accompanying table:

<table>
<thead>
<tr>
<th>Canned capacity in water at 68° F. (in ounces)</th>
<th>Maximum head space allowable measured from top of double seam in sixteenths of an inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.94</td>
<td>8.8</td>
</tr>
<tr>
<td>16.70</td>
<td>9.9</td>
</tr>
<tr>
<td>15.22</td>
<td>9.5</td>
</tr>
<tr>
<td>16.88</td>
<td>9.4</td>
</tr>
<tr>
<td>20.55</td>
<td>9.7</td>
</tr>
<tr>
<td>59.22</td>
<td>11.4</td>
</tr>
<tr>
<td>109.43</td>
<td>13.6</td>
</tr>
</tbody>
</table>
Artificially Colored Peas

Certificates of grade covering canned peas that are artificially colored shall bear the following statement in addition to the statement of grade:

"Below U. S. Standard—Low Quality but not Illegal Because Artificially Colored"

ASCERTAINING THE GRADE

The grades of canned peas may be ascertained by considering the following factors: clearness of liquor, absence of defects, uniformity of size and color, tenderness and maturity, and flavor of peas and liquor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits which may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Clearness of liquor</td>
</tr>
<tr>
<td>II. Absence of defects</td>
</tr>
<tr>
<td>III. Uniformity of size and color</td>
</tr>
<tr>
<td>IV. Tenderness and maturity</td>
</tr>
<tr>
<td>V. Flavor</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Note.—When grading so-called “vacuum-pack” peas, the factor of “clearness of liquor” shall be disregarded. The other four factors shall be scored, the total of which shall be multiplied by 100 and divided by 85 for the final score, dropping any fractions.

Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means 12, 13, and 14.

I. Clearness of Liquor

(A) To receive a rating within the highest group, 13 to 15 points for this factor, the liquor surrounding the peas must be practically clear; that is, presenting not more than a slight cloudiness.

(B) If the liquor is reasonably clear, possessing a small quantity of visible sediment, 11 to 12 points may be allowed.

(C) If the liquor is somewhat roily, with an accumulation of sediment readily noticeable, or is slightly off color, 8 to 10 points may be allowed.

(D) If the liquor is badly clouded, possessing a considerable quantity of sediment, or is badly off color, from 0 to 7 points may be allowed.

II. Absence of Defects.—This factor has reference to workmanship, care in preparation, and the degree of freedom from broken, off-colored, spotted peas, skins of peas, thistle buds, and other material that would ordinarily be removed in careful preparation.

(A) Peas that are practically free from the defects mentioned may be given a credit of 14 to 15 points.

(B) If the peas are reasonably free from such defects, from 11 to 13 points may be allowed.

(C) If the defects are prominent, from 8 to 10 points may be allowed.

(D) Peas in which the defects are decidedly prominent, in excess of 4 per cent by count being off-colored (brown, brown spotted, white, or yellowish white), or in excess of 20 per cent by count being broken, are entitled from 0 to 7 points credit.

III. Uniformity of Size and Color.—The various sizes of peas may be described as follows:

No. 1 size peas are peas that will pass through a screen of $\frac{8}{10}$-inch mesh.

No. 2 size peas are peas that will pass through a screen of $\frac{11}{10}$-inch mesh, but not through a screen of $\frac{8}{10}$-inch mesh.

No. 3 size peas are peas that will pass through a screen of $\frac{8}{12}$-inch mesh, but not through a screen of $\frac{11}{12}$-inch mesh.

No. 4 size peas are peas that will pass through a screen of $\frac{9}{10}$-inch mesh, but not through a screen of $\frac{8}{12}$-inch mesh.
No. 5 size peas are peas that will pass through a screen of \( \frac{3}{16} \) -inch mesh, but not through a screen of \( \frac{1}{32} \) -inch mesh.

No. 6 size peas are peas that will fail to pass through a screen of \( \frac{3}{16} \) -inch mesh.

*Note.*—If the peas are declared to be ungraded for size, the rating for this factor shall be based on “uniformity of color,” and cognizance shall not be taken of “uniformity of size.”

(A) Peas that are uniform in size and color may be given a credit of 9 to 10 points for this factor.

(B) If peas are slightly lacking in such uniformity, from 6 to 8 points may be allowed.

(C) Peas that are irregular in size and/or variable in color, may be given a credit of 3 to 5 points.

(D) If peas are markedly irregular in size or markedly off color, from 0 to 2 points may be allowed.

IV. TENDERNESS AND MATURITY

(A) To receive a rating within the highest group, 32 to 35 points, for this factor, the peas must be very young and very tender.

(B) If the peas are less tender than those of the first group, a score within the range of 28 to 31 points may be allowed.

(C) If the peas have somewhat tough skins and are somewhat mealy or starchy, but require less than 2 pounds of pressure to crush the cotyledons to one-fourth their original thickness, from 25 to 27 points may be allowed. Peas that fall in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) If 10 per cent by count of the peas are so mature that they require a crushing force of 2 pounds or more to crush the cotyledons to one-fourth their original thickness, or the skins are very tough, from 0 to 24 points may be allowed.

V. FLAVOR.—The determination of flavor shall be based on the flavor of the product and shall be classified from the standpoint of palatability.

(A) If the flavor is typical of very young, tender, succulent, fresh garden peas, a credit of 22 to 25 points may be allowed.

(B) If the flavor is typical but not so pronounced as in (A) above, from 19 to 21 points may be allowed.

(C) If the flavor is palatable, from 16 to 18 points may be allowed. Peas that fall in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) If the product possesses an “off” flavor, from 0 to 15 points may be allowed.

There are no data available to indicate the relative proportions of these grades. The closest approach was that obtained upon the offerings to the army during the war. Of 695 lots of peas given a detailed grading by the writer, the following is a summary.

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. lots</th>
<th>Per cent</th>
<th>Gross weight Grams</th>
<th>Net weight Grams</th>
<th>Drained weight Grams</th>
<th>Liquor weight Grams</th>
<th>Vacuum inches</th>
<th>Per cent no. vacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fancy</td>
<td>241</td>
<td>34.6</td>
<td>700</td>
<td>588</td>
<td>371</td>
<td>217</td>
<td>5.8</td>
<td>15</td>
</tr>
<tr>
<td>Standard</td>
<td>352</td>
<td>50.6</td>
<td>700</td>
<td>584</td>
<td>370</td>
<td>218</td>
<td>6.2</td>
<td>15</td>
</tr>
<tr>
<td>Substandard</td>
<td>102</td>
<td>14.8</td>
<td>691</td>
<td>579</td>
<td>382</td>
<td>194</td>
<td>5.9</td>
<td>25</td>
</tr>
</tbody>
</table>

Upon the basis of 13.5 ounces (383 grams) being the minimum weight for peas in a No. 2 can, only 208 lots or 28 per cent were full weight and these were divided as follows: Fancy, 53 lots or 25.4 per cent; Standard, 101 lots, or 48.5 per cent; and Substandard, 54 lots, or 26 per cent.

**Sampling**

Frequent sampling is of more importance in the canning of peas than with most products. In addition to the regular daily sampling it is well to
send marked cans through whenever there is noticeable variation in the
quality of peas from any cause and to make an examination as soon as the
cans are cool. The experienced superintendent will thus be able to make
slight adjustments in fill and changes in blanching or cooking to keep the
pack more nearly uniform. By such means he is frequently able to detect
faulty operations of viners or other defects before large quantities of peas
have passed through.

Troubles

The packing of peas is attended by troubles of a more or less serious
character, swells, flat sours, cloudy and starchy liquor, and discoloration.

Swells are almost invariably due to insufficient cooking either in the de-
gree of temperature used or in the time allowed. This may be said to be
invariably true in the case of large numbers of swells developed shortly
after packing. When swells develop occasionally over a period of several
weeks, the trouble is most often due to can leaks. Swells were the first form
of spoilage to be investigated bacteriologically, and the results reported
under the title "Gaseous Fermentation in the Canning Industries," in 1895.
The accompanying type of spoilage, souring, was first studied by S. C.
Prescott and L. M. Underwood and presented in a paper "Souring of
Peas" before the canners convention in 1901. Souring is most often asso-
ciated with non-cooling or insufficient cooling after the cooking in the
cans, due to the fact that the organisms responsible for its development
grow best only at abnormally high temperatures. Stacking or piling
the cans while hot holds the heat for days in the cans in the interior of the
pile and thus favors the growth of the thermophilic bacteria. A cook which
will give an excellent product when cooled promptly may be found to be
insufficient for preservation if cooling be omitted. The importance of cool-
ing was stressed in the discussion of this paper. The present day packer
can have no conception of the enormous losses sustained by the pioneer
canners from these two causes. Another important early work is that by
Harding and Nicholson of the New York Agricultural Experiment Sta-
tion, on "A Swelling of Canned Peas Accompanied by a Malodorous De-
composition," 1903, as they used factory experiments of considerable size
to carry out the work. Others have contributed much since that time so
that swells, flat sours, and leaks are more a matter of history than a present
problem.

Cloudy and starchy liquor is normal to peas that are fully developed and
becoming mature. The condition is due to starch and the greater the num-
ber of grains set free by the breaking of the skins, whether by the beater
in shelling or ruptured in cooking, the more unattractive will be the prod-
uct. The amount of turbidity can be controlled to an appreciable extent
by the care given in the preparation, the degree and time given in cooking,
and by prompt thorough cooling. The flocculent amorphous material pres-
ent in the liquor on the better grades has been designated by a German in-
vestigator as one stage in the formation of amylogen, and that the objec-
tionable cloudiness is made worse by prolonged heating.

Discoloration occurs due to the use of excessive heat in the cooking, to
stack burning, from the activity of certain bacteria, and from the presence
of iron and copper.
The most common cause is that due to heat, resulting in a dull brown color and occurring rather uniformly on all peas in a can or lot of cans. It occurs when the cooking temperature is above 236° and the higher the temperature, the more pronounced the effect. A temperature considerably in excess of 236° may be attained if done rapidly and uniformly and held for only a short time. Discoloration also occurs in stack burning but in that case it is accompanied by general softening and an odor of overcooking.

Certain forms of bacteria liberate hydrogen sulphide as a by-product of their activity and peas infected with these organisms and not sterilized become dark with individual peas black. The hydrogen sulphide combines with the iron in the brine to form the black iron sulphide. Fortunately this type of spoilage is not common and when it does occur, it is under conditions similar to that of flat sours. The fullest account of such an outbreak is by E. J. Cameron, before the National Canners Association in 1928.*

Discoloration from iron sulphide is not so prominent as with a light colored product but it often occurs to such an extent as to give a dark effect. The inside of the cans become badly darkened, especially along the side seam and on the die marks in the head space. The small particles of black become distributed through the brine on being shaken. The discoloration of the peas is not localized to the same extent as in corn or other heavy products which are not moved about freely in the can.

A different form of discoloration, more of a brownish black or brownish hue, and more generally distributed on the peas is also ascribed to iron by Duckwall, but in this case to iron in the water. It occurs only where the water carries a high iron content and in peas packed in glass as well as in tin. In glass packed products the discoloration is not quite so prominent. By precipitation of the iron through preliminary boiling of the water and settling, the trouble largely disappears.

**Discoloration from Copper**

Coloring peas by means of salts of copper has been known for a long time and prior to the enactment of the pure food laws the greening by that method was fairly common in this country as well as in Europe. During all the time when it was used and also when peas were blanched in copper kettles, no records were made of peas turning black due to copper. In 1914, the research laboratory of the National Canners Association found copper caused a dark discoloration in corn under certain conditions and in 1916 Duckwall pointed out that it might also be a cause of blackening in peas and string beans, though he cited no specific instances of such occurrences.

In the summer of 1923, black peas were found in a western pack with a history of some similar trouble in 1922 and also in 1912. Some cans contained a few black peas, some with a round black spot on one side, and others with a more or less diffuse coloring. The discoloration occurred in only a small percentage of the cans and in the majority of these there were less than a half dozen seeds, though in some the number might possibly reach fifty.

Copper was immediately suspected but chemical tests gave a negative result. The factory was new and equipped with the latest type of machinery.

*"The Canning Trade," February 13, 1928."
The only piece of apparatus not standard was a gravity grader having copper separating boxes. The peas came directly from the rotary grader by sizes and were in the copper boxes 35 seconds and in the brine 10 seconds. All peas received the same treatment but all lots were not affected which seemed to eliminate this device as the source of trouble. Raw peas were then placed in some of the copper boxes, in galvanized iron baskets, and on enamel trays for 12, 3, 2, and 1 hours respectively, then blanched and canned. Darkening occurred in some peas in each set exposed to the copper but not nearly to so pronounced a degree as in the regular run of peas, but no darkening in those in the other lots. Copper strips, iron strips, galvanized metal strips, and other materials were placed in the cans with the peas and processed in the same manner as in the regular factory run but no blackening occurred under these conditions. A test was made to determine the shortest time in which blackening could occur when peas were exposed to copper, using blanched and unblanched peas, both in the air and under water. From these experiments it was observed that scalded peas exposed to copper in the air for 35 seconds showed some darkening after canning while those exposed for 1½ minutes became black. In those exposed under water the effect was very much less pronounced and only about 20 per cent as many showed any effect. Most of the peas would have attracted no attention had one not been looking for trouble. The raw peas exposed under the same conditions showed nothing in the short period but had about the same amount of discoloration after 15 minutes exposure in the air as occurred in the blanched peas in 35 seconds. In no case did all the peas coming in contact with the copper show discoloration, it was limited to 12 to 16 per cent.

From these experiments and other observations it was determined that the trouble occurred at the filling machine which was provided with a copper extension on the hopper. The blanched peas were conveyed in buckets from the blancher and dumped into the hopper. When the machine was operating constantly and at capacity, the peas tended to pass directly down through the center of the hopper and thus a certain amount on the outside might remain in contact with the copper for a variable though short time. When the flow of peas from the blancher slowed down for any reason, some of the peas from the sides rolled in and when the flow stopped, all of them passed into the cans. It was when there was a slowing or stopping of the machine that the blackening occurred or when the peas which had remained in contact with the copper passed into the can with others. Another source of the trouble was in a receiver from one of the gravity graders. A sufficient quantity of one grade was not available at all times to make a batch for the blancher and occasionally there might be a delay of an hour or more waiting for peas to accumulate. These peas were not thoroughly washed after coming from the gravity bath and when held an unusual time would develop a nearly uniform darkening but not nearly so deep in color as occurred in those contaminated after blanching at the filling machine.

The foregoing is given in detail as illustrative of the difficulty which may be encountered in locating and proving a source of trouble even when reasonably certain of its character.
By-products

The vines which once were a waste product and had to be disposed of as a direct expense are now considered a valuable by-product to be converted into silage or hay. It is in conserving this material that the viner station has proven most useful as it keeps the material in the country where it does not constitute a nuisance while fermenting, and is located most conveniently for the feeding of animals. The accumulation of hundreds of tons of silage near a factory or within a city is always a subject of criticism. In the country the stacking can be done in the open and with little waste. If the amount of vines be small at any time, they can be distributed over a field and dried for hay. Both the silage and hay have a good food value. An analysis made by W. J. Jones, Jr., Indiana Agricultural Experiment Station, is as follows:

### COMPOSITION OF PEA VINE AND SWEET CORN SILAGE

<table>
<thead>
<tr>
<th></th>
<th>Pea Vine Silage</th>
<th>Sweet Corn Silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture at 100° C</td>
<td>77.49</td>
<td>81.62</td>
</tr>
<tr>
<td>Crude protein</td>
<td>3.566</td>
<td>16.027</td>
</tr>
<tr>
<td>Ether extract</td>
<td>8.39</td>
<td>3.777</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>6.556</td>
<td>29.466</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>8.708</td>
<td>39.134</td>
</tr>
<tr>
<td>Crude ash</td>
<td>2.582</td>
<td>11.602</td>
</tr>
</tbody>
</table>

### Pea Vine Hay

| Moisture             | 7.120          |
| Crude protein        | 9.760          |
| Ether extract        | 1.720          |
| Crude fiber          | 23.290         |
| Nitrogen free extract| 51.304         |
| Ash                  | 6.800          |

Waste

The small material separated in the factory, the overflow from the blanchers, washer, etc., constitute a waste that is so large that its discharge into a small stream or other body of water causes pollution of an offensive character. The condition may be avoided or mitigated by separating the particles in suspension by means of screens or filters, and the final effluent be treated by appropriate methods such as described in another section. The part caught in the screen makes good hog feed but can be fed more profitably raw than when dried.

### Composition of the Pea

While the pea does not have the importance in the dietary in this country which it formerly held and still holds abroad, especially when mature, it is highly appreciated when green both for its nutritive qualities and flavor. The small white bean, in the form of canned pork and beans has largely displaced the dry pea. Attempts to can the dry peas in the same manner as the bean, that is, as ripe peas with pork, have met with little success.

The pea is even more nutritive than the bean, the composition of both dry and green peas as given by Wiley is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Ash</th>
<th>Protein</th>
<th>Fiber</th>
<th>Starch</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent</td>
<td>Per cent</td>
<td>Per cent</td>
<td>Per cent</td>
<td>Per cent</td>
<td>Per cent</td>
</tr>
<tr>
<td>Green pea</td>
<td>79.93</td>
<td>.78</td>
<td>3.87</td>
<td>1.63</td>
<td>13.30</td>
<td>.49</td>
</tr>
<tr>
<td>Dry pea</td>
<td>12.62</td>
<td>3.11</td>
<td>27.04</td>
<td>3.90</td>
<td>51.75</td>
<td>1.58</td>
</tr>
</tbody>
</table>
The protein element is especially high. The pods are not eaten as they are thin and fibrous. Abroad they are cooked and rubbed in a colander, sufficient pulp being thus obtained to form the base for purée.


The bureau has received a number of inquiries regarding the form of label which should be used on the product heretofore designated as “soaked peas.” This question was fully answered by the Board of Food and Drug Inspection in the letter quoted below:

Dear Sir: We have been endeavoring to secure as much information as possible, both from our experts and from the canning trade, as to the proper labeling of this product. From the information thus gathered it appears that the proper designation for this product is “soaked dried peas” or “soaked ripe peas,” as the case may be. The Board of Food and Drug Inspection is of the opinion that the terms “dried peas” and “ripe peas” are not proper designations for these products, inasmuch as they are the names of other definite substances. Our inquiry does not show that there is any particular objection in the trade to the term “soaked peas.” It would appear that the term “soaked peas” is a shortened expression of the legend “soaked dried peas” or “soaked ripe peas,” which has naturally grown up among the manufacturers and which from long usage has come to represent, to both the consumer and the trade, a definite food product. The board is of the further opinion, however, that no objections could be raised to the designation of these products as “peas, prepared from dried peas,” or “peas, prepared from ripe peas,” as the case may be, provided the modifying phrase “prepared from dried (or ripe) peas” be plainly stated in immediate connection with the word “peas,” the whole phrase thus forming the name of the product. We understand that the trade recognizes a difference between dried peas and ripe peas, the dried peas being the peas gathered in the succulent state and dried and the ripe peas being those which have ripened on the vine.

S. R. A. 42. The Labeling of Canned Soaked Peas.

In the opinion of the bureau, the use of a vignette showing peas in the pod would not be considered proper on a label for canned soaked peas, for the reason that it might lead the purchaser to believe the product to be canned fresh peas. There would be no objection, however, to the use of a pictorial design which would not mislead purchasers as to the nature or quality of the product, such, for example, as a vignette showing a dish containing shelled peas.

S. R. A. 318. Weights of Peas and Unpitted Cherries in Cans of Various Sizes.

An investigation recently concluded by the bureau indicates that properly filled cans of peas should, in general, yield the following drained weights of peas, the weights being determined in each instance by draining for 2 minutes on a \( \frac{1}{4} \) inch mesh screen:

- **No. 1**: 21 \( \frac{1}{2} \) by 4 inch sanitary, and hole and cap cans ............................................ 7.5 ounces
- **No. 2**: 3 \( \frac{3}{4} \) by 4\( \frac{1}{2} \) inch sanitary, and 3\( \frac{3}{4} \) by 4\( \frac{1}{2} \) inch hole and cap ........................................ 13.5 ounces
- **No. 10**: 6\( \frac{1}{2} \) by 7 inch sanitary, and 6\( \frac{1}{4} \) inch hole and cap ........................................ (72 ounces) 4 pounds 8 ounces

Cans of peas of low specific gravity yielding somewhat lower drained weights than these will be regarded as properly filled. On the other hand, cans of peas of high specific gravity should yield drained weights somewhat greater, to be regarded as acceptably filled. By means of the information obtained in this investigation, the bureau will be able to determine in each instance whether cans of peas of high and low specific gravity yield the drained weights which properly correspond to the specific gravities in question. In all cases, however, the can should be packed as full as practicable without injury to quality. This guiding principle is believed to be consistent with the requirements of weight here indicated.


Inquiries have been made concerning the propriety of labeling domestic canned peas as “petit pois” peas.

It is the bureau’s opinion that the term “petit pois” has lost such geographic significance as it may have had. Peas canned in the United States may, therefore, be
labeled with this term, provided they are of the size of the peas that have been import¬
ported from France under this labeling—that is, the No. 1 sieve size.

S. R. A. 389. Labeling Soaked Dry Peas and Lima Beans

It has been found that the wording employed on canned soaked dry peas has fre¬
quently created the impression that the peas were canned in the succulent state and
that this impression has been furthered by the pictorial designs employed, such as a
vignette showing a dish of green-colored, succulent-appearing peas. This product
should be labeled "soaked dry peas," or with an equivalent expression, in type of equal
size, on a uniform background, in order to differentiate it clearly from succulent peas.
No pictorial design which would contribute to the impression that the product is
 canned succulent peas should be employed. Opinion 18, page 111, Service and Regu-
latory Announcements, Chemistry 3, and opinion 42, page 313, Service and Regula-
tory Announcements, Chemistry 5, are amended accordingly.

This announcement is equally applicable to the labeling of canned soaked dry lima
beans.

PATENT APPENDIX

Shelling Devices

Patents Nos. 213,168, March 11, 1879, and 220,800, October 21, 1878,
issued to J. Budd, Philadelphia, Pennsylvania, are for a hand machine for
shelling peas from the pods. The pods pass from a hopper over a roll which
scarcifies them and in the next step they pass between two rolls which cause
the peas to be squeezed from the pod.

Patent No. 252,616, January 24, 1882, issued to F. Molini, San Fran-
cisco, California, is for a shelling device in which the peas pass between
a solid roll and a spiral cut roll.

Patent No. 260,494, July 4, 1882, issued to A. Meyer, Baltimore, Mary-
land, is for the first power driven machine designed to have considerable
capacity. The pods are rolled and beaten between two wire belts to cause
them to split open and discharge the peas.

Patent No. 289,699, December 4, 1883, issued to G. Paci, New York,
New York, is for a device consisting of a coarse horizontal screen in the
form of a revolving disk and above it an elastic stationary cushion. In pass-
ing between the two, the friction on the pods causes them to open.

Patent No. 337,960, March 16, 1886, issued to M. F. Kidd, Baltimore,
Maryland, is for a device consisting of two horizontal plates, each provided
with pegs so spaced that one disk can revolve while the other remains sta-
tionary. The peas are supposed to be released from the pods by the action
of the pegs.

Patent No. 382,988, May 15, 1888, issued to R. Karges, Brunswick,
Prussia, is in reality for a separating device to be used in connection with the
Faure type of pea sheller. "My invention relates particularly to attach-
ments for pea shelling machines having a cylindrical revolving screen in
which longitudinal beaters are spirally arranged, and which are provided
with longitudinal sweeps." The separator consists of a series of vibrating
inclined riddles to free the peas from the broken pods.

Patent No. 387,388, August 7, 1888, issued to R. P. Scott, Baltimore,
Maryland, is for the first successful podder developed in this country, and
is the immediate ancestor of the viner. The patent is intimately related to
Patent No. 421,244 and the two should be considered together. The opera-
ration is described in the body of the patent as follows:
The peas in the hulls or pods are fed into the slowly revolving cylinder by the propeller or feed screw. They are then elevated to a point above the horizontal center of said cylinder by means of its interior longitudinally arranged ribs. They then fall from said ribs, and in their descent are struck with sudden or impact blows by the rapidly-revolving openers or beaters, which split the pods or hulls, release the peas, and throw them against the inner sides of the cylinder. The released peas then pass to the lower surface of said cylinder, drop out of the same mainly through the perforation in the leather-covered portion thereof, and fall upon that part of the inclined apron which is directly beneath, down which they roll, notwithstanding the upward movement of the upper surface of said apron, and are delivered into any suitable receptacle, the hulls or open pods and the refuse being carried over the upper end of the apron, and thus are gradually conveyed toward the discharge end of the cylinder by the obliquely-arranged beaters or openers (not shown), and pass out through the large meshes of the wire-netting at that end, the said netting serving to deliver the hulls loosely and separately upon the apron and to scatter them out over a larger surface than would be possible were said netting not used and the hulls discharged at the rear end of the cylinder or through the annular space or opening 24, as in either of the latter events the hulls or open pods would be dumped out upon the apron in a mass and prevent any peas that may remain in said hulls or pods from being properly separated therefrom. Thus it will be evident that the released peas and open pods or hulls are delivered out of the cylinder at different points, fall upon the inclined apron at different points, and remain practically separate from each other while being agitated and delivered, respectively, at the lower and upper portions of said apron. Any open pods or hulls that are too large or from other cause fail to pass through the meshes of the wire netting are discharged through the opening 24, and any peas that may remain in open pods or hulls that fall upon the apron will be shaken out by the agitating action of the same, caused by its passing over the prismatic rollers or reels, whereupon the released peas will roll down and off the apron, while the hulls and any refuse mingled therewith will be carried up and discharged from the upper end of said apron.

In running over the prismatic reels or skeleton rollers the apron will be kept sufficiently stretched or tightened, and, also, at the same time the shaking or vibrating motion will be imparted to the entire apron, and thus a much better effect produced than is incident to the jarring of aprons by knockers and the like.

It is a well known fact that it is extremely difficult to cause a wide belt or apron of canvas or other material to run straight over rollers and at the same time permit of the necessary vibration for effecting a proper separating action, and, so far as I am aware, these results have hitherto been but indifferently obtained. In my machine, as stated, the apron is not only caused to run straight, but receives an abundance of vibration, and also prevents peas and hulls from escaping over its edges. I accomplish the result of keeping the apron straight in its passage over the rollers by providing it with the interior transverse slats and causing them to project against the side boards. The slats, although overlapping at their adjacent ends, serve the same purpose as would solid slats, so far as guiding or keeping the apron straight is concerned, but at the same time, owing to their peculiar construction and arrangement, they will bend out of a straight line, but not sufficiently to prevent their ends from forcibly pushing against the side boards. This bending or hinging action of the slats at their ends also permits the apron to be raised at its sides or edges, so as to roll the peas toward its center, and also it allows said apron to receive greater vertical throw or toss than would be incident to the use of solid or unjointed slats running its entire width, since, were the latter used, their solid ends would rest upon the inclined guide flanges of the side boards and thus prevent the full drop of the apron and diminish its vibration. This apron while in operation supports a considerable weight of peas and hulls, and this causes more or less friction upon and wear and tear of said apron as it passes over the rollers and against the side boards, in time rendering it necessary to substitute one or more new aprons. For this reason I contemplate furnishing extra aprons with my machine, or subsequently supplying them as separate articles of manufacture and sale.

An important distinction between my machine and that disclosed in the application above referred to resides in the fact that my apron extends the full length of the cylinder, so that the hulled peas and such dirt as pass through the perforations of said cylinder and fall upon the apron will lie upon one portion thereof, while the open pods or hulls and such peas as may be mixed therewith will be carried along toward the rear end of said cylinder, pass out through the wire netting or the opening and fall upon another portion of said apron, whereas in practice the apron of the machine
embraced in the application named does not extend the entire length of the cylinder and has no agitation for separating the hulled peas from the mass of open pods or hulls which fall at the end of the cylinder, and consequently a perforated chute has to be employed for the open pods or hulls to be discharged upon. As stated, in my machine the apron runs straight and true, receives the necessary vibration for effecting proper separation, and prevents the hulled peas from rolling over its edge.

Patent No. 390,125, September 25, 1888, issued to W. Hollingsworth and H. R. Travers, Baltimore, Maryland, is for a machine similar in principle to that of 337,960, but of heavier construction with the shelling plates set vertically. In addition it has a rotary screen for separating the shelled peas from the broken pods.

Patent No. 394,630, December 18, 1888, issued to S. Wilson, Brooklyn, New York, is for a hand power machine to hull peas by squeezing the pods between two rubber rolls.

Patent No. 399,702, March 19, 1889, issued to R. P. Scott and J. A. Chisholm, and for improvements by one or both in subsequent Nos. 499,-397, June 13, 1893; 500,299, June 27, 1893; 957,442, May 10, 1910; 957,-443, May 10, 1910; 1,072,176, September 2, 1913; 1,082,609, December 30, 1913; 1,107,207, August 11, 1914; and 1,263,130, April 16, 1918, are for a device to shell peas from the pods while the latter are still attached to the vine. This is generally known as the viner. The principle is the same as that in the Faure machine and in the podder but the machine is stronger and with minor changes in the mechanical construction. The operation is described in the first patent as follows:

The operation of our improved machine is as follows: The vines and the peas in the pods attached thereto are fed into the feed end of the separating cylinder, which receives them between its longitudinal bars or ribs and carries them slowly upward until they are caught by the beaters of the more rapidly revolving hulling drum and carried over the edge of the curved knives, which cut them into suitable lengths for proper treatment within and passage through said cylinder. The relative speeds of the separating cylinder and the hulling drum are preferably about as fifteen is to one hundred and sixty. The beaters of the rapidly revolving drum strike the pods on the vines with sufficient force to open them and release the peas, which then pass out through the perforations in the covering of the separating cylinder. The beaters, as stated, are adjustable upon the periphery of the drum, so as to assume more or less obliquity or spirality by means of the slotted transverse bar, which, by loosening the set-screws, can be turned upon the drum shaft, and thus said beaters made to assume more or less obliquity with respect to the periphery of the hulling drum. It follows from the construction and arrangement of the parts just named that the vines and pods will be fed toward the open discharge end of the separating cylinder with more or less rapidity, according to the degree of obliquity or spirality that is imparted to said beaters. The front ends of the flat bars composing the beaters have sufficient play within the vertically slotted brackets to admit of their being adjusted by turning the transverse bar upon the drum shaft, the rear ends of said beaters being also mounted in the radial slots formed in the ends of said bar that they will admit of slight play therein, and yet be held firm or secure. The knives cut the vines into proper lengths to permit free action of the beaters thereon for opening the pods and to prevent said vines and pods from bunching or becoming clogged in the separating chamber. While only two of these knives are shown in the drawings, which under ordinary circumstances will be sufficient, a larger number may be employed if necessary or desired. The vines are also prevented from becoming twisted or entangled with the impact openers or beaters, from the fact that their inner edges rest upon or close to the periphery of the hulling drum, and thus said vines will be freely fed without obstruction from the feed end to the discharge end of the separating cylinder.

Patent No. 412,005, October 1, 1889, issued to W. F. Smith, Holton, Georgia, is for a device using intermeshing pegs or fingers for breaking
the pods. These are given a reciprocating motion instead of a rotary motion as in previous patents.

Patent No. 421,244, February 11, 1890, issued to C. P. and J. A. Chisholm, Oakville, Canada, is for a “Method of Hulling Peas.” The device used is similar to that of Madam Faure as far as the drum and beaters are concerned. A description of its operation is given as follows:

We are aware that in addition to the usual mode of shelling peas by hand several processes of accomplishing the same object by machinery have been proposed—as, for instance, passing the pods between elastic rollers, opening the pods by passing them through the intermeshing fingers, and by rubbing the pods between abrading surfaces, all of which have been found to bruise and injure a large proportion of the peas, and are therefore very objectionable in actual use. Now we have discovered that green peas may be hulled by impact while in free air, and the process of this application is based on this discovery. By “impact” we mean the striking of a solid body against the pods while the latter are so situated that nothing but the resistance of the air holds them against the action of the solid body.

The impact may be given by a variety of apparatuses. For instance, a paddle, beater, or impact opener in the hands of a workman, swung with just the proper velocity, impacting the peas while falling through the air, would execute this process, but we prefer the apparatus in the accompanying drawings, in which—

Figure 1 is a perspective view with parts broken away. Figure 2 is a cross section of the same without the outer casing.

In this apparatus the peas are carried to an elevated position in the upper portion of a revolving cylinder, from whence they drop, and while falling through the air they are struck by beaters, which revolve preferably in the same direction as the cylinder, but at a much greater rate of speed. The cylinder should revolve at just such a speed as not to carry the pods around by centrifugal force, but carry them up and drop them, and in falling through the air they are struck by the beaters, which may or may not be covered by some soft material (as rubber or leather) to soften the blow. The pods must be struck by a sharp quick blow, which should be just sufficient to crack them open; that is, to sever the connection of the two half-shells of the pod, the connection of the peas with the pods being severed by the same operation. The air naturally confined in the pods protects the peas from being bruised.

In the machine which we have shown, and which by preference we employ to execute our process, the inside diameter of the cylinder is about thirty-six inches, the length of the cylinder is eight feet, and the length of each beater or impact opener, measured from the geometrical axis of the cylinder, is sixteen inches. With a machine of these dimensions the revolutions of the cylinder should be about eighteen per minute, while the beaters should make about one hundred and eighty revolutions in the same time. These dimensions and speeds are given so as to enable a workman to carry out this process without further experiment. They are in no way to be taken as limiting us to any specific dimensions or to the precise speed. Should, however, the speed be increased to five hundred to six hundred revolutions per minute, the principle of operation would be changed and the peas could not be successfully hulled.

In order that the peas may not remain in the cylinder—that is, accumulate to such an extent as to impede the progress or become injured by the beaters—we provide the covering of the cylinder with perforations somewhat larger than the peas, so that the peas will immediately escape through said perforations as they are removed from their pods.

Patent No. 428,958, May 27, 1890, issued to E. E. Sanford, Milan, Tennessee, is for a combination toothed sheller and beater.

Patent No. 433,302, July 29, 1890, issued to G. Paci, New York, New York, is for a device for shelling peas from the pod and consists of a series of abrasive drums operating in concaves having abrasive points that are mounted against springs instead of being rigid.

Patents Nos. 437,987, October 7, 1890, and 466,021, December 29, 1891, issued to J. W. Harbin, G. H. Olney, and J. W. Harbin, New York, New York, is for a device which depends upon squeezing the peas from the pods as they pass between rolls.
Patent No. 450,051, April 7, 1891, issued to H. B. Babitt, Paxton, Indiana, is for a huller employing the principles of the Faure machine but modified in mechanical construction.

Patent No. 457,351, August 11, 1891, issued to E. C. Moulton, San Francisco, California, is for a small batch type of podder, suitable for hotel use rather than a factory.

Patents Nos. 486,441, November 22, 1892; 527,954, October 23, 1894; 546,095, September 10, 1895; 604,377, May 24, 1898; 738,894, September 15, 1903; 773,854, November 1, 1904; and 773,859, same date, issued to J. H. Empson, Longmont, Colorado, are for machines using the shelling principle of the Faure machine but modified in detail. The separation of the shelled peas from the pods also differs.

Patent No. 489,929, January 17, 1893, issued to H. T. Clark and C. B. Russell, Bridgeport, Connecticut, is for a household sheller using the roller principle for squeezing the peas out of the pod.

Patent No. 496,206, April 25, 1893, issued to N. Placide, Paris, France, is for a device similar to the Faure machine but improved in detail.

Patent No. 513,911, January 30, 1894, issued to D. A. Gaither, Willsiston, Tennessee, is for a device consisting of a series of beaters with intermeshing prongs or teeth to break the pods open.

Patents Nos. 527,956, October 23, 1894, and 795,498, July 25, 1905, issued to J. H. Empson and P. McDonald and the second to J. H. Empson, Longmont, Colorado, are for devices for shelling the peas from the vine using large cylinders with heavy spikes.

Patent No. 540,774, June 11, 1895, issued to A. W. Armstrong, Columbus, Nebraska, is for a podding machine using the principle of a cylinder with teeth and a concave.

Patent Nos. 553,774, January 28, 1896, 593,426, November 9, 1897, and 682,908, September 17, 1901, issued to H. H. Brakely, Bordentown, New Jersey, is for an improvement on a sheller using the Faure principle. It consists in removable sections in the separating cylinder.

Patent No. 581,073, April 20, 1897, issued to C. A. Ketcham, Pillowville, Tennessee, is for a huller employing the principle of a cylinder with spikes intermeshing with others held stationary and beaters to break the pods open.

Patent No. 688,510, December 10, 1901, issued to B. Hicks, Vicksville, Virginia, is for a machine to take pea pods off the vines.

Patent No. 693,926, February 25, 1902, issued to A. Thomas, Northeast, Pennsylvania, for a viner in which the pea vines are carried on the usual type of chain conveyor and above which are sets of beaters which strike the vines and pods.

Patent No. 719,618, February 3, 1903, issued to J. P. Scoville, Chicago, Illinois, is for a podder. The pods are carried through a hot oven to be opened and then between belts to be loosened and separated from the peas.

Patent No. 722,895, March 17, 1903, issued to B. E. Preston, Denver, Colorado, is for a culinary pea huller.

Patent No. 728,759, May 19, 1903, and 752,256, February 16, 1904, issued to W. F. Pillmore and D. Andergregg, Westernville, New York, is for a machine of the usual type of cylinder but having multiple small beaters instead of one.
Patent No. 733,215, July 7, 1903, issued to G. W. Kelley, Russell, Pennsylvania, is for a device for stripping the pods from the vine.

Patent No. 738,145, September 8, 1903, and 913,678, March 2, 1909, issued to E. G. Albaugh, Frederick, Maryland, are for the usual type of viner but with two internal beaters.

Patent No. 767,086, August 9, 1904, issued to J. P. Scoville, Wyoming, Ohio, is for a device to squeeze peas from the pod by means of grooved rollers.

Patent No. 772,691, October 18, 1904, issued to F. H. Chase, Chicago, Illinois, is for a small type of podding machine in which the pods are rubbed between a wire screen and a conveyor.

Patent No. 803,809, November 7, 1905, issued to W. C. Combest, Paulding, Mississippi, is for a podder employing two spiked cylinders, the spikes interneshing.

Patents Nos. 909,587, January 12, 1909; 1,035,184, August 13, 1912; 1,153,304, September 14, 1915; 1,394,765, May 27, 1919; 1,340,607, May 18, 1920; 1,357,047, October 26, 1920; 1,361,051, December 7, 1920; 1,390,781, September 13, 1921; 1,405,914, February 7, 1922; 1,421,772, July 4, 1922; 1,430,736, October 3, 1922; 1,525,181, February 3, 1925; and 1,645,324, October 11, 1927; issued to A. L. Hamachek, Kewaunee, Wisconsin, are for modifications of details on the usual type of viner.

Patent No. 957,444, May 10, 1910, issued to T. A. Scott, Cadiz, Ohio, is for a means of changing the pitch of the beaters at the discharge end of the viner so that the vines may be struck more frequently without being forced out.

Patent No. 1,116,948, November 10, 1914, issued to E. M. Stewart, Boston, Georgia, is for a culinary pea sheller. Rolls and a pin are used.

Patent No. 1,118,673, November 24, 1914, issued to W. Northrop, Hopedale, Massachusetts, is for a device suited to podding peas for hotels, restaurants, etc. It embraces the usual rotary cylinder having perforations and within which are balls either free or connected with the shaft by means of a chain to act as beaters to break the pods open.

Patent No. 1,269,211, June 11, 1918, issued to C. H. Plummer, Kewaunee, Wisconsin, is for a viner in which a web on one side elevates the peas to a position to be struck by the beaters. It takes the place of the usual cylinder. No. 1,415,896, May 16, 1922, is for an improvement on the same.

Pea Graders for Size

Patent No. 435,153, August 26, 1890, issued to N. G. Numsen, Baltimore, Maryland, is for a machine having vibrating screens with holes of different sizes to separate the peas accordingly.

Patent No. 827,909, August 7, 1906, issued to J. H. Empson, Longmont, Colorado, is for a device employing rotary screens so arranged that the large size peas are taken out first and thus increased the grading capacity for the other sizes.

Patent No. 1,147,283, July 29, 1915, issued to J. W. Tuttle, Baltimore, Maryland, is for the rotary type of grader nested so as to economize on floor space.

Patent No. 1,483,092, February 12, 1924, issued to P. C. Kraska, Amery,
Wisconsin, is for a vibrating grader, constructed so as to be more easily cleaned and adjusted.

Patent No. 1,605,541, November 2, 1926, issued to G. Glass, Milwaukee, Wisconsin, is for a nested grader made of half cylinders and to be given a rocking motion.

Pea Graders by Gravity

Patent No. 515,542, February 27, 1894, issued to W. H. Webb, Longmont, Colorado, is for an apparatus consisting of a tank to hold brine of any density desired and a conveyor at the bottom to carry off such peas as may settle in the bottom and another which will skim off such peas as may float. The graders are determined upon the basis of peas being heavier or lighter than the brine. The following is given as an objective:

This invention relates to grain separator machines, and it has for its object to provide an improved machine of this character, which, while particularly adapted for the separation of green from ripe peas for the convenience of canning factories, at the same time is also adapted for use as a grain separator for the separation of oats and barley and weed seeds from wheat, and other separations which will be hereinafter referred to.

To this end the main and primary object of the present invention is to provide an improved separator machine which dispenses with the ordinary sieve and air currents and relies particularly upon the natural specific gravity of the elements to be separated from each other.

Patent No. 874,623, December 24, 1907, issued to R. B. Polk, Greenwood, Indiana, uses the principles of the Webb machine but with a different mechanical arrangement.

Patent No. 915,832, March 23, 1909, issued to G. H. Dekker, Ootsburg, Wisconsin, utilizes the principles of the Webb machine with some variation in the mechanical features.

Patent No. 1,018,715, February 27, 1912, issued to G. J. Lange, Eau Claire, Wisconsin, is for a brine tank with worm and bucket conveyors to carry off the separated peas.

Patent Nos. 1,069,143, August 5, 1913, and 1,143,202, June 15, 1915, issued to F. O. Keene, Freeport, Illinois, is for a tank divided so that peas in the bottom of the first compartment can be discharged into the second through gates. A conveyor from each compartment handles the different grades.

Patent No. 1,086,011, February 3, 1914, issued to T. O. Ballard, Franklin, Indiana, is for a device in which a large spiral worm carries the peas at both the top and bottom of the solution to different conveyors.

Patent No. 1,312,098, August 5, 1919, issued to A. Cerruti, San Francisco, California, is for a tank built in the shape of a large hopper, the light peas are skimmed off the top and the heavy ones floated out of the bottom by means of a tube and pump.

Cleaning and Washing Peas

Patent No. 542,810, July 16, 1895, issued to R. P. Scott, Cadiz, Ohio, and J. A. Chisholm, Oakville, Canada, is for a process of cleaning green peas. It consists primarily in treating the peas in a rotary wire drum after blanching. The perfect peas roll over the end and the splits, skins, and other debris pass out between the wires. Later a perforated pipe was placed in the drum and it then became known as the squirrel-cage washer and was
used chiefly before blanching. The part of the patent relating to the treat-
ment of peas at that time is exceptionally clear and is herewith reproduced:

"Ever since the invention by the Chisholm brothers, covered by United States
Patent No. 421,244, of the mechanical, impact process of preparing peas for the cans
have been about as follows: The green peas have been hulled in a perforated cylinder,
falling from these onto an inclined endless apron which acts to partially clean the peas,
the impurities passing to the upper and the green peas rolling to the lower end of the
apron. The peas were then sorted in a sorting-cylinder and at the same time were
subjected to an air-blast for removing any further impurities, such as dirt, pea shells,
pea skins, and the like. After this the peas were blanched; that is to say, they were
subjected for about a minute to the direct action of boiling water, which, it is supposed,
removes any starch which may exist near the surface. This blanching is important and
has been and is universally used by all canners for giving the peas a color which
renders them more salable and for making a clear liquor in the can. The blanching also
adds to the cleanliness and removes a rank taste of the pea. The operation of blanch-
ing, however, softens the pea skins, so that any skins which might be split or bruised
drop off. To remove these split peas and pea skins the peas have heretofore been
passed over flat cleaning tables with girls standing at each side, who picked out the
skins and split peas by hand. After this the peas were filled into cans, processed, and
sealed.

Green peas have always been considered about the most delicate vegetable which
packers handle, and after the green peas have been blanched, as above described, and
have thereby in effect been partially cooked and rendered soft, it has always been con-
sidered impossible by those skilled in the art to subject such blanched peas to any
mechanical cleaning process.

According to our invention after the peas have been blanched, we run them, to-
gether with such impurities as may not have previously been removed and with the
split peas and pea skins which may have been developed by the blanch, into the rotary
cleaning device above described, the whole forming a mass of some thickness upon
the bottom of the cylinder. The rotation of the cylinder conveys a gentle rolling mo-
tion to all the peas, and the inclination of the cylinder passes the peas toward the dis-
charge end. A pea, for instance, which lies between two adjacent wires E will in the
rotation of the cylinder be rolled around by the friction against these wires and against
the superincumbent mass of peas. Any pea shell, pea skin, or split pea which gets into
the neighborhood of the grating will thus be rolled around a wire E by the peas and
pass through to the outside of the cylinder. Again, since the split pea skins are soft and
flabby, having been made so by the blanch, they will be more readily rolled out between
the wires than would have been the case with the rather springy split pea skins before
the blanch.

Pea Cleaner

Patent No. 1,091,534, March 31, 1914, issued to E. Reynolds, Sturgeon
Bay, Wisconsin, is for an apparatus to remove thistle tops from peas. A
semi-circular tank is provided with a conveyor at the bottom to remove the
peas which sink in water and another to skim the thistle tops which float
on the surface.

Pea Blancher

Patent No. 697,272, April 8, 1902, issued to C. H. Plummer, Waukesha,
Wisconsin, is for the standard cylindrical style of blancher but divided into
sections, each of which is supplied with its own steam line but with the
water line entering at the discharge end, running through the sections, and
discharging at the opposite end. It follows that the cleanest and hottest
water is at the discharge where most effective, and that a large part of the
dirt and gummy substances are removed before the peas enter the cleaner
sections. It is the cleanest type of blancher, and admits of better regula-
tion than the undivided type but has a rather limited capacity.

Patent No. 740,758, October 6, 1903, issued to H. D. Hutcheson, New-
ark, New York, is for a device having a series of hoppers mounted on a
conveyor belt; peas are delivered into the hoppers and are carried under a washer, thence into a tank of hot or boiling water for the desired time and out under another washer and are then discharged into a receptacle to receive a given size. More than one size of pea can be blanched at a time as more than one line of hoppers may pass through the same tank.

Patent No. 886,097, April 28, 1908, issued to E. J. Vaudreuil, Two Rivers, Wisconsin, is for the bucket type of blancher, the buckets being conveyed through a tank of hot water in a given time. The special feature in this case is a stirring device in the bucket to obtain a more even distribution of heat among the peas. It represents a marked improvement over the earlier type of bucket blancher.

Patent No. 1,131,299, March 9, 1915, issued to E. J. Vaudreuil, Vaudreuil, Wisconsin, is for a machine to blanch small units of peas in just sufficient water for the purpose with each batch. The batch boxes are carried through a conveyor type of exhaust box and then dumped into a spray washing device.

Patent No. 1,154,675, September 28, 1915, issued to E. J. Vaudreuil, Eau Claire, Wisconsin, is for a unique U-shaped spiral mounted upon a shaft and submerged in a water bath or heated by steam. The peas are measured in batches and a corresponding amount of water added to each batch. The batches pass through the spiral as units.

Pea Holding Apparatus

Patent No. 1,055,353, March 11, 1913, issued to C. H. Plummer, Black Hawk Falls, Wisconsin, is for a series of tanks with a water circulating system to hold peas temporarily.

Patent No. 1,164,861, December 21, 1915, issued to C. H. Plummer, Kewaunee, Wisconsin, is for a cabinet to receive boxes of shelled peas and to force circulation of air about them to prevent heating. It is for temporary storage only.

Pea Separating Apparatus

Patent No. 856,356, June 11, 1907, issued to I. S. Merrill, Syracuse, New York, is for an apparatus to separate broken peas, skins, and other defective material from peas as they come from the shelling machine. The peas are first run over a vibrating screen to shake out such material as can be eliminated that way and then over a series of shelves, the drop between the shelves being sufficient to cause the good peas to bounce into pockets and the defective ones to roll into a compartment.

Patent No. 882,084, March 17, 1908, issued to E. J. Vaudreuil, Two Rivers, Wisconsin, is for a belt studded with small pegs and made to run on an incline. Peas are fed upon the belt, the sound peas roll down over the belt while the skins and imperfect material are caught and carried off.
The peppers comprise a large number of varieties of capsicum and like their close relatives, the tomato and the eggplant, are natives of the tropical Americas. They were unknown in Europe prior to the discovery of this continent. Some botanists claim that Guiana is the home of this plant and that it was distributed over the northern part of South America, Mexico, and the southern part of this country by the native peoples during many centuries of migrations. It was one of the plants that attracted the attention of Columbus who reported it as unlike any known plant in Spain and that it had fruit possessing pepper-like qualities to an extraordinary degree. Upon his second voyage, he found that it was cultivated by the Indians and that the fruit constituted the only condiment used in their foods. The seeds were carried to Spain in 1514, and the plant given the name pimiento from pimients meaning pepper in the Spanish tongue. The Portuguese gave it the designation pimenta. Other terms were applied which translated are “Pepper of India,” “Pepper of Brazil,” and “Guiana Pepper,” indicative of its western origin, and “Coral of the Garden” as expressive of the color of the fruit. The Spaniards who penetrated into Mexico and down the western coast to Peru found the plant cultivated by the Aztecs and Incas under the name “chilli,” which term, with a varied orthography, persists especially for a large, long, rather hot variety grown in Mexico and in the southwestern states. The people of the tropics ate the hot peppers with a relish and apparently with no more regard for the fiery pungency than do persons who eat young radishes or onions in the north. The peculiarity has persisted with the succeeding generations to the present time. Later investigations have shown that the peppers were used even prior to the races then living in that section so that it has been domesticated for a long time.

The Plant

The plant was described first in 1506 by Valerius Cordus, a botanist, and again by Oviedo upon his arrival in this country in 1514. It was cultivated as an ornamental plant upon its introduction into both Spain and Portugal but its use as a garden vegetable quickly followed. As with some other vegetables, it was believed to have medicinal virtues especially beneficial to the stomach so that it was much sought after. Distribution to Italy, Greece, and Turkey followed rapidly and from the last country it was carried to Hungary where it became known as paprika. The plant was also carried northward but was considered an ornamental one because of the beauty of the pods rather than a vegetable so that by the middle of the 16th century it was known over a considerable portion of Europe either as a new vegetable or an ornamental plant. It was carried to England in 1548. The more northern people did not like the flavor and in consequence it received little attention as a new addition to the list of vegetables. Several varieties were described at that time varying from mild to pungent but only two distinctive strains were developed due to differences in selection, culture, and climatic conditions and these have persisted. One, a large, smooth, fleshy-walled, sweet strain grown in Spain already referred to as the pimiento, and the other a smaller fruit, thin walled and only moderately pun-
i

The pepper was also introduced into Mombassa and Madagascar in Africa, and Kobe, Japan, at an early time, but in these cases it was a small-fruited variety, generally known as Cayenne. From these places the dried pods return to us as an article of commerce.

Though peppers are tropical plants, a number of varieties are grown as annuals as far north as the Great Lakes and New York state. They grow as perennials below the frost line and present wide variations with the different varieties. The stems are branching, from one to six feet in height; leaves ovate or acuminate, glossy; flowers white or greenish white but not attractive; the fruits are pods that vary from less than one inch to seven inches in length and from one-quarter of an inch to three inches in diameter; in shape, from slender and sharply acuminate to short and truncated; of a green color when immature to brilliant red, yellow, and violet when ripe. The seeds are small and attached to a central core. The most distinguishing characteristic is the presence of a pungent principle, capsaicin, which varies widely in amount in the different varieties.

Horticultural Varieties

While botanists and horticulturists list several species and many varieties of peppers, one may roughly place them in six classes based upon their uses. First, the very small varieties, usually about one inch in length, and extremely hot and pungent, best represented by the type used in making Tabasco sauce. The center of commercial production is in western Louisiana but the parent stock came from Mexico. Second, Cayenne, or red peppers, small fruited varieties, pods slender, usually less than two and one-half inches in length, decidedly hot and pungent and used chiefly in the dry powder as a substitute for pepper or to produce more pungency than pepper. It is imported chiefly from Africa and Japan. Third, Hungarian pepper or paprika, a larger and heavier podded variety from two and one-half to four inches in length and three-fourths of an inch or more in diameter, with a bright red color and slight pungency. These are frequently called sweet peppers. The ground powder is used both as a condiment and for the bright red color which it imparts to food. Fourth, Bell peppers, large podded varieties from two and one-half to four inches in length and two inches in diameter, irregular in outline and with a blunt end. The walls are thin and only moderately pungent. They are used both green and ripe, fresh, pickled, or in salad. These are grown in northern kitchen and market gardens. Fifth, Chilli peppers, sweet chillies or American, and hot chillies or Mexican. These are large varieties from four to seven inches in length, generally about one and one-quarter inches in diameter and conical in shape. They are deep red, the walls rather thin, the American variety only moderately hot but the Mexican decidedly pungent. They are grown chiefly in the southwest and in Mexico, are used fresh, both green and ripe, and dry, both whole and ground. They constitute a part of many Mexican dishes, particularly those containing meat, and also are used in various sauces, especially those containing tomato. The green sweet chillies are canned in considerable quantity and both green and ripe hot chillies are comminuted and canned as it is the best means of preserving their char-
acteristic flavor. Sixth, the pimiento, a large sweet pepper of Spanish development, grows from three to four inches in length and one and three-quarters to three inches in diameter, rather conical in shape, fairly smooth, well colored, with thick walls of a sweetish and very mild pungent taste. It has been grown for a long time in Spain and Portugal but only since 1900 in this country. It is the finest of the peppers for mild flavor and attractiveness in garnishing. One of the favorite uses abroad is for the stuffing of olives. It was the first pepper to be canned, considerable importations being made until 1920, since which time domestic canning has supplied the market. When dried, it has a different flavor from the Hungarian strain.

Cultivation
The growing of peppers is simple. The seeds are planted early in the spring by drilling in rows 3½ feet apart, and 10 inches apart in the row. Germination and growth are slow at first but, when once started, growth is fairly rapid as the plant is a good feeder and needs rich soil and plenty of moisture. In California it is grown only on irrigated land. When the plants are well started, they are thinned to 20 inches apart and require frequent cultivation. In Georgia the seed are sown in beds and the plants protected until five or six inches in height, then they are set in the field at about the same spacing as indicated. Harvesting begins in September and continues until December. A precaution that must be observed is to keep the varieties well separated, as they cross easily and thus change from the type desired. Considerable losses have been experienced from neglect of this precaution, even necessitating importation of fresh seed to reestablish the stock. The yield of pimientos in Georgia is given as 1½ to 4 tons per acre with an average of 2½ tons. The yield in California for the same pepper and for chillies is somewhat higher. In both varieties of peppers the early crop is of better quality than the later. The prices paid in Georgia average thirty dollars per ton.

The harvesting in Georgia is done in baskets and the peppers carried to the factory loose in wagons or in crates. In California the picking is done in baskets and the peppers sacked for delivery to the factory. The light weight, 33 pounds to the bushel, makes the handling in sacks more economical than in fruit lug boxes. Only fully ripe pimientos are picked and it is customary to allow them to stand one or two days in the sacks to allow the color to develop uniformly in the tissues. A dark red color makes a fancy pack, while a light one makes only a standard.

Canning
The canning of peppers is limited practically to chillies and pimientos, only a few of the smaller and hotter strains being canned for Mexicans who have come into the states or for persons fond of the Mexican style of cookery. The pioneer canner in this country is E. C. Ortega of Los Angeles, California, who began packing chillies at Ventura in 1898. After experimenting until he found a successful method of preservation and also demonstrating that there was a market for the product, he moved his factory to Los Angeles in 1902. By 1907 he had increased his production to 42,000 cases. As usual in such instances, a number of others were glad to share the rewards of his industry and other factories were
established in the city or nearby and that section has since remained a center of production. The canning has increased to the point where it requires the cultivation of several thousand acres to supply the demand. Statistics are not available upon the packing of chillies and pimientos separately, but the combined pack in 1929 was 506,000 cases.

Mr. Ortega used the green chilli as most suitable, as the ripe chilli softens in the roasting and is prone to break in the handling so that it loses in attractiveness. The packers who have followed have not deviated to any appreciable extent from his procedure. He imitated the Mexican style of removing the tough skin by developing a special apparatus which gave essentially the same effect upon a large scale as obtained by subjecting small lots to fire or to heat from a hot rock, a crude method which seems to have been inherited from the Indians by the white settlers. His roaster consisted of a metal drum about twenty feet in length set on a slight incline in a furnace in which the fire could be regulated to give the temperature best suited for the purpose. The drum was made to rotate slowly so that the peppers entering at one end were turned slowly but often enough to expose all parts uniformly and without burning and were discharged from the opposite end in about 40 seconds. This simple device proved effective and economical in operation and an important advantage claimed for it is that the flavor is the same as in home preparation. The roasted peppers are conveyed directly to tables where the skin is squeezed off and the core with the seeds attached pulled out. If necessary, the stem is released by cutting around the base, using a peach pitting spoon. The removal of the core and seeds eliminates the harsh pungency that is objectionable to many persons. The trimming and coring are hand operations usually carried out by Mexicans or colored persons as they can handle the peppers with impunity, whereas whites must wear rubber gloves and even then are often subject to skin eruption. The waste in peel and cores amounts to practically 40 per cent or more.

The peeled pods are washed under sprays to remove adherent bits of skin, etc. They are carefully folded and packed into cans. The heating of the pepper in the process of roasting is sufficient to soften the pod so that the folding can be done without danger of breaking. Broken pods, soft pods, and those which develop color are cast out to be used in chilli sauce. The regular pack goes into cans 3 inches in diameter and 2½ inches in height so that, in filling, a solid or nearly solid pack may be attained. If anything be added, it is 1½ per cent brine. A good exhaust is desirable to draw all the air or gases out of the folds and tissues and for this purpose 10 minutes at 180° F. is not too much. The cook is from 15 to 18 minutes at 212°. The broken chillies are run through an Enterprise style of grinder and packed in No. 1 tall cans.

In 1907, John Bonhoff of Los Angeles, developed a system of roasting the peppers in cottonseed oil heated at temperatures varying from 260° to 400° F. Open tanks were set directly over a furnace for heating the oil, and for the lower temperatures a closed steam coil was used in a retort. The peppers were placed in crates, covered to prevent floating, and then the lot submerged until the skins were loosened, the time being from three to four minutes. This was followed by washing in hot water to remove the adherent oil. The method was not an improvement over that of roasting the chillies and practically went out of use. It has been revived and im-
proved for the roasting of pimientos. The method had been in use in household culinary operations so was in reality an adaptation on a large scale of a principle already well known.

Lye peeling has also been tried but that likewise has not been a complete success.

Another line of chilli packing is in a minced form for hot sauce. In this case the peppers are washed, then the base with the hard stem cut off. The remainder is run through an Enterprise grinder, after which sufficient brine added to make it thoroughly moist but not sloppy. No attention is paid to the removal of peel or core and seeds. The chopped material is heated in a kettle and held at the boiling point for two or three minutes to produce the effect of exhausting and then packed in No. 1 or No. 10 cans. The No. 1 cans are cooked 25 minutes at 212° and the No. 10 cans for 1 hour, assuming that the filling has been done at a high heat and handled properly. The larger part of this style of preparation is packed with tomatoes as hot sauce. The proportion of chilli is about one-sixth or less to that of the tomato. This is also packed in No. 1 cans for family use and No. 10 cans for restaurants and hotels. The cook for the mixture is the same as for tomatoes.

This style of packing is less expensive than where peeling is done but the result is also a less delicate product. It is better adapted for the ripe than for the green chillies. The principal consumption is in the South though there is a constant gain in the North.

Pimientos

The canning of pimientos abroad is much older than in this country. It is said to have been started in Spain in 1820 and that it was the first, or one of the first products packed in that country. It is difficult to either verify or disprove the statement though from the general data concerning canning in that country, it seems improbable. It is a fact, however, that it was packed there long before it was in any other place. The canned product was imported into this country in small but constantly increasing quantities from the early ’80’s until 1920, since which time local production has taken its place to a large extent. It seems reasonably certain that Mr. Ortega was also the first packer of pimientos in this country, using the same method followed with chillies, but after experimenting one season, 1907, adhered to the packing of chillies as being more remunerative. He obtained his seed from Spain. C. J. Waldin, * states that the Royal Packing Company, Los Angeles, packed 500 cases of pimientos in 1908 and 2,100 cases the year following. Several companies claim to be the originators. One of the first press notices was that by Wayman and Riegal, Pomona, Georgia, given out through The Canning Trade, December 22, 1913. The No. 2 can was used and the product pronounced satisfactory. The war arrested the work for the next few years.

Georgia Method

The history of the Georgia development is about as follows: The pimiento had been grown as a fresh market vegetable since 1900, the seed having been obtained from Spain. Fortunately the manner of adapting the strain to the local conditions fell into capable hands and it also happened

*The Western Canner and Packer, March, 1928.
that what proved good for the vegetable market also proved good for canning. The peppers were of fair size, about 4½ inches long, 1¾ inches or more in diameter, pod thick and firm with a fine bright color and mild flavor. The major part of the adaptation and improvement was done by S. D. Regal, though others worked along similar lines. The canning was taken up in earnest in 1919 by W. L. Grafe. As a first step, only fully ripened fruit were harvested and graded into three sizes as they arrived at the factory. The No. 1 size consisted of pods which would not pass between bars spaced 2 inches apart. The No. 2 size consisted of those which would pass between bars spaced 2 inches but not 1¾ inches apart, and the No. 3 size or culls consisted of those which would pass through the latter opening. Graders were built which produced these three grades and thus simplified the subsequent factory operations. The graded peppers were then washed in drums under sprays of water.

The next step consisted in developing a machine to remove the stem and core with the seeds. This consisted of a small revolving cutter head which made a circular cut about an inch in diameter around the stem and within which automatic suction drew out the core with the seeds attached. These machines worked as rapidly as it was possible to place the base of the pepper in position against the cutter head. The cored pepper fell upon a conveyor belt and was carried to the roasting furnace.

Another special development consisted of a firebrick tunnel about 25 feet long, within which was a chain conveyor having upright fingers upon which the peppers were placed while the chain was in motion. The tunnel was heated by jets and the flame made to play upon the peppers so that they emerged with the skin roasted black. The time required for passing through the tunnel was from 20 to 25 seconds. The peppers fell from the fingers and were immediately sprayed with water to wash off the skin and to arrest the action of the heat, then conveyed directly to the tables where any adherent bits of skin were removed and the pods folded and placed in cans. It was found that the heating in the furnace was so superficial that blanching in hot water for one and one-half minutes and then chilling, expedited the folding and also resulted in better workmanship, so that step was incorporated. The chilli can was adopted as being the most easily hand-filled and also held an amount well suited to the trade. It is now generally known as the pimiento can. The filling was practically the same as for the chilli, a nearly solid pack of folded peppers with only enough brine to fill the interstices. Some were also packed with cottonseed oil in imitation of the foreign style as that conserves the color better and slightly modifies the flavor. The other cans now used are the 7, 20 (No. 2) and 26 (No. 2½) ounces; the time for sterilizing in boiling water varies from 20 minutes for the 7 and 15 ounce cans, 25 minutes for the 20 ounce, to 45 minutes for the 26 ounce cans.

The development of both the system and equipment is unique in canning history in being different from previous canning procedure, also in that all parts were developed at one time and place. Though used only in a few plants, the effect was to make Georgia prominent as a canning center for the packing of pimientos.
California Packing

Coincident with the foregoing development was another in California. Seed was obtained from Spain about 1914 and the first trials at canning were conducted according to the methods followed in the packing of chillies but the results were not all that could be desired. The occurrence of the war arrested the work temporarily so that it was not taken up again until 1920, since which time two methods of treating the peppers have been developed, one dependent upon the oil bath for roasting the skins, and the other upon the gas flame and the subsequent treatment modified to fit the method of roasting. In both, certain steps have been made continuous in order to secure uniformity in treatment and to keep hand labor at a minimum.

The procedure for roasting peppers in oil is as follows: The pimientos which have been held in bags for a day or more to color and to wilt slightly are graded for size, discharged directly into a tank of water for preliminary soaking, and as they come out on a belt, are cleaned by sharp sprays of water. They fall upon a conveyor which carries them through the oil tank at a fixed rate. A second wire belt at the top of the oil bath runs in unison with the conveyor and forces the peppers below the surface of the oil, thus assuring an absolutely uniform treatment. A tasteless mineral oil is used and maintained at 400° F. by a furnace immediately below the tank. The ability to obtain this high temperature without imparting a burnt or foreign flavor constitutes a successful improvement. The time in the bath is determined by the condition of the peppers. The pods are carried out several feet over a drainboard to drip and to recover the adherent oil and are then discharged into a drum washer where they are first sprayed with hot water to get rid of any oil remaining and to remove the skins. The work is completed under cold sprays. Whether the pods are given a subsequent steam or hot water bath depends upon whether they are softened sufficiently for folding without breakage. On small sized fruit and those harvested late in the season this blanching may be omitted, otherwise steaming or heating for one and one-half minutes is advantageous for better appearance. The removal of the stem, core, and seeds, and also the folding and packing into cans are the same as for chillies.

The other western development has been that of a furnace for roasting which differs from the Georgia style in that instead of having a conveyor with impaling fingers to hold the peppers, it is flat and the peppers ride through loosely, are struck by the gas flame from so many directions that they are turned over a number of times, and thus insure that every part is acted upon. As the pods emerge, they fall directly into a rotary washer and are subjected to sharp sprays of water to remove the charred skins. The stems and cores are removed in the same manner as chillies with the other operations the same as have been described already. A still later modification is to make the furnace from thirty to forty feet in length, inclined at an angle of thirty degrees or more so that the fruit rolls through by gravity in about eight seconds.

Patents covering the first roaster are Nos. 1,660,061, February 21, 1928, and 1,736,107, November 19, 1929, issued to A. I. Addison, Long Beach, California.
Filling the Cans

The folding of the pimiento is important as it is used for garniture as often as for flavor. For the former purpose the pods are cut into long strips or into figures and if the folding be improperly or carelessly done, there is loss or it may not even serve its purpose. Four large peppers fill a regular pimiento can. The No. 2 and No. 2½ cans are used for broken pieces that go into cheese, sausage, thousand island dressing, and other like preparations. A 4 ounce size, $2\frac{1}{4}$ inches in diameter and 2 inches tall holding three medium peppers is also being marketed.

The cooking now used in the West for sterilizing the 4 and 7 ounce cans is 15 minutes, the regular pimiento can 20 minutes, the No. 2 can 30 minutes, and the No. 2½ can 50 minutes. The chilli and pimiento are both considered easy to sterilize but I have found heat resistant organisms on different occasions.

One western packer makes a specialty of packing the pimiento in glass, using the 2 ounce jar. The amount thus packed in 1928 was 76,000 cases, or in round numbers 7,500,000 jars.

For the best possible appearance, the pimientos in glass are packed solid, the pieces manipulated with wooden paddles or bone spatulas to close any air pockets. It is usual to select jars of either two or four ounce capacity. The cooking is carried on at 212° or below and from 25 to 50 minutes, the object being to get the temperature in the center about 200° for 25 minutes.

A pimiento specialty has been patented under No. 1,434,663, November 7, 1922, issued to Charles Ortega, San Diego, California. The descriptive part is as follows:

My invention relates to the method for flavoring and packing pimientos and the objects of my invention are: First, to provide packed pimientos with special flavoring; second, to provide packed pimientos which are very delicious; third, to provide a novel method of packing and preparing pimientos; fourth, to provide a novel pimiento product; and fifth, to provide a novel method of producing flavoring for the same as will be hereinafter described in detail and particularly set forth in the appended claims.

Although I understand my invention might be applicable to various kinds of packed vegetables and fruits it is particularly applicable to pimientos and green chilli and I will therefore hereinafter refer to the product and process in relation to pimientos.

It is generally understood that in the method generally employed in packing pimientos, that the pimientos are first scalded to remove the peel, then cored and packed in cans with considerable liquid from the pimientos in connection therewith and in some cases certain known flavorings are used in connection.

I have discovered that a special flavoring produced from tomatoes under a certain process introduced in connection with the pimientos gives it a special and delicate flavor which is very palatable and highly delicious in flavor.

I have also discovered that by removing a portion of the fluid from the pimientos under a certain process causes the pimiento to remain whole while packing without in any way toughening the same.

In carrying out my method for producing the product I prefer to proceed in the following manner:

First: The outer surface of the pimiento is roasted by subjecting its outer surface to a heated surface which causes the easy removal of the peel while the body of the pimiento remains intact. The pimiento is then cored and washed. It is then subjected to sweating by steaming, preferably in a steam chest where it is subjected to live steam until about one-fourth of a pound of water is removed from three pounds of pimiento, after which the pimiento is seasoned with salt and like seasonings, then packed in cans.
and a special flavoring added, which flavoring is produced by steaming and crushing tomatoes, skimming the upper surface and letting stand about twelve hours, after which the liquid therefrom is drawn from the bottom, strained, and is ready to be added to the pimiento as hereinbefore set forth, after which the can is closed in the conventional manner.

Although I have disclosed a certain pimiento product and a certain method of packing and preserving the same, I do not wish to be limited to the particular description for packing and preserving the pimiento but desire to include in the purview of my invention the packed pimiento and method of producing the same substantially as set forth in the appended claims.

Composition

The composition of the pimiento has been studied at the Georgia Agricultural Experiment Station and reported as follows:

Pimiento peppers have 68.74 per cent shell (edible part), 15.64 per cent placenta (core), 6.26 per cent stem, and 9.36 per cent seed. Bell peppers have 82.64 per cent shell (edible part), 12.21 per cent placenta (core), and 1.87 per cent stem, and 3.28 per cent seed.

The pimiento shells have about 88 per cent water, the stems 87 per cent and the seeds 48 per cent. The ash of the shell has 32.5 per cent potash and 15 per cent phosphoric acid. The shells have 3.04 per cent sugar and 1.25 per cent protein, green basis. The average water content of bell peppers from the field was 88 per cent.

An analysis of pimiento shells (edible part), on a dry basis showed:

<table>
<thead>
<tr>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
</tr>
<tr>
<td>Protein (Nx 6.25)</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
</tr>
<tr>
<td>Crude fiber</td>
</tr>
<tr>
<td>Fat (ether extract)</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The bell pepper has also been found to be rich in vitamin A.

Waste

The waste in canning pimientos is about 60 per cent, and so far no particular use has been found for it other than to return it to the soil as fertilizer. However, a use has been found for the cull pimientos.*

The ground pimiento mixed with mash fed to laying hens will impart a deep yellow color to the yolk. This was particularly noticeable during the winter when the yolks are normally pale. No other effect was observed. The most striking result was obtained when the amount of pimiento was about one per cent of the mash.

POTATO

*Solanum tuberosum

The potato is an annual plant, grows from one to three feet in height, has a rather fleshy stem and compound leaves, white, pinkish, or purplish flowers having prominent yellow stamens, and is distinguished for producing many large and starchy tubers. It is native to the Andes in Peru,

*Woodroof, J. G. and Bailey, J. E. Georgia Experiment Station, Bul. No. 150.
Morgan, W. A. and Woodroof, J. G. Georgia Experiment Station, Bul. No. 147.
Chile, and adjoining countries in South America. The first mention occurs in a diary by one of the explorers in 1535 stating it was obtained from the Incas at the time of the conquest of their country. Introduction into Spain occurred in 1555 or 1556 and in the meantime it was distributed to other Spanish colonies in the islands and on the mainland. It was not adopted as a food as promptly as many other acquisitions from the New World but had become distributed in some parts of Europe by 1565. History records that it was first grown in England in 1586 but not in Ireland until 1663, where it became the most important and dependable crop. It is so intimately associated with the husbandry of that country that it is generally known as the Irish potato. It was adopted as a field crop in Germany in 1772 and has since become a mainstay as a food, source of starch, glucose, and stock feed. More potatoes are used in that country than any other of equal population. The potato found little use in France until about 1800 when Parmentier strongly advocated its cultivation because of its high food value and for diversification in their agriculture. Teaching and argument were not very effective so he resorted to a ruse which had the desired result. He had a field planted near Paris and guards stationed about it to give the impression that the plants were rare and of special value. At the proper time the guards were withdrawn under some pretext with the result that the potatoes were stolen and the succeeding year many patches of the valuable tuber appeared, some at considerable distance from the original. Inside a decade the potato became a common vegetable. The tuber is widely distributed in both temperate zones as it is easily propagated by dividing the tuber though seldom grown from seed.

The tuber has a very high starch content and keeps well in reasonably dry cool storage so is generally held fresh.

The evaluation of the potato by comparison with other vegetables is expressed by Gibault in the following paragraph:

"For all the people of the white race inhabiting the temperate countries of Europe and America, the potato ranks with wheat as the principal food of vegetable origin. It is the most useful gift the New World has made to us. Cultivated to only a limited extent at the end of the 18th century, its expansion has been prodigious during the course of the 19th century, and in our day the land planted to potatoes has increased each year. It is necessary to recall here the services which this tuber renders to the laboring classes. The introduction of the potato in alimentation has removed forever the specter of famine which formerly periodically devastated Europe. Both a horticultural and an agricultural plant, it is cultivated alike in the kitchen garden as well as on a large scale for the table, for feed for domestic animals, for the starch industry, and for distilling."

Canning

The canning of the potato is most often done upon special orders for points in Alaska, the Philippines and other places where there is a white population and fresh tubers cannot be procured. The canned potato is not a complete success, as it tastes like cold or reheated potato and cannot be served in many of the ways used for the fresh potato.

The preparation is simple. The potato is peeled and cut into long strips as for French fried, blanched until flexible, then filled rather closely into
cans, covered with a two per cent brine and cooked at 240° F. for 50 minutes for No. 2½ cans.

**New Potatoes**

More recently the canning of new potatoes has been making progress for the reason that the product much more closely resembles the original than in the case of the mature potato. In 1929, packing was begun in an experimental way at Palatka, Florida, and repeated the following year on a much larger scale. This was followed by packing in Kansas.

In the digging of potatoes for the early market there are always a quantity too small to meet the market grades and fortunately these are the best for canning. These small potatoes are screened out and used very soon, as the skins are removed more easily while the tubers are fresh, with less waste in peeling and also from injuries.

The potatoes are thoroughly washed in a rotary washer and delivered into specially made abrasion peeling machines. These are built on the plan of the regular machines but made of wood and of much larger size. They are lined with hard rough fiber. A heavy beater on a central shaft causes the potatoes to be driven against the grater. It requires little force and not much speed to remove the skin.

The potatoes are discharged on a washing belt and played upon by sprays to remove any adherent skin. As they pass beyond the washer, they are inspected and any imperfectly peeled ones picked out. Small patches of skin are rubbed off, but tubers with large unpeeled portions are returned to the machine.

The finished stock is discharged on the filling tables or in a hand filling machine. The principal packing is done in No. 2 cans for household use and in No. 5 cans for restaurant trade. From 10 to 12 potatoes fill a No. 2 can. A 1½ per cent brine is added and a heavy exhaust given since there is no blanching. The time in the exhaust box is 10 minutes or more.

The cook is given as 40 minutes at 236° F. for the No. 2 can and 50 minutes for the No. 5 can.

The Florida factory is reported to handle 400 barrels of potatoes per day.

**PUMPKIN AND SQUASH**

*Curcurbits*

Pumpkin and squash are terms which have been and still are used for very closely related vegetables but which are applied so indiscriminately or used so indifferently in various sections that one is rarely sure just which is meant. This is not strange since their habits of growth are alike and there is more difference between the gross appearance of the fruits of some of the squashes and also some of the pumpkins than between some of the different varieties of pumpkins and some of the squashes. The differences between these two plants and fruits are based upon botanical characters and thus vary in technical details rather than upon such points as are apparent to the general observer. The treatment of the two are, therefore, considered together.
Historical

These vegetables are native to this continent and, like corn and beans, have been cultivated by the Indians over a wide territory and for a long time before the arrival of Columbus. They are mentioned by him in a memorandum of December 3, 1492, as grown as part of immense fields "planted with many things of the country and calabashes (pumpkin)." Cabeza de Vaca, July, 1528, found near Tampa Bay in Florida, "beans and pumpkins in abundance." De Soto found western Florida "well supplied with maize, beans and pumpkins," and Cartier, when exploring the St. Lawrence wrote that he saw among the Indians of Canada "great quantities of large melons, cucumbers and courges (pumpkins)." The fruit were more than food for in this case they were a symbol in their religious rites and in their folklore. The term "squash" was obtained directly from the aborigines and has persisted in the English tongue. Pumpkin, however, was a term given to the plant and fruit by European gardeners.

The use of the fruit for food was learned from the Indians, for gourds are their closest relatives in the old world and these were grown for ornamental and decorative purposes. Only one variety was comestible and that was quite different from the newly found plant. The seeds of the new fruit were carried to Europe and became widely disseminated within a short time, in fact so quickly that when botanists began to study species closely and look for native habitats of the cultivated plants, doubt arose as to whether it was a native or an exotic. The fact that they were never mentioned in manuscripts upon cookery prior to the discovery of this country lends support to their distinctly American origin. The great variety in the fruit and the abundance of production by the plant is taken as evidence of its long domestication and cultivation.

The Plants

The Curcurbits are plants of a trailing habit, having a wide spread, large tender leaves, both vines and leaves distinctly hairy, flowers large, usually light or yellow set on a short stem, followed by a large fleshy hollow fruit within which are many flat seeds.

The pumpkins include two species, Curcurbita pepo and Curcurbita moschata, while the squash is limited to one species, Curcurbita maxima. The simplest point by which they can be differentiated is in their fruit stems. The stem on the pumpkin is hard and of a woody nature, generally furrowed with five longitudinal furrows or in some cases these may be described more properly as ridges or fins. The stem on the squash is distinctly softer, is not grooved or ridged and is generally expanded at the point of attachment. Both pumpkins and squashes have been greatly modified by cultivation. There are long and flat ones, irregularly shaped and crooked necks, globular with flattened ends, large ones weighing from 20 to 75 pounds and even more, to small ones weighing but a few ounces to one or two pounds, smooth to warty skins, in color from a deep yellow through light to a deep gray and mottled greenish, in texture from so hard that they can be cut with difficulty to so soft that they can be crushed between the hands. Probably most persons more or less familiar with pumpkins and squashes think of the Connecticut Field, a long yellow variety, and Kentucky Field or Large Cheese, a flattened yellow variety, both com-
mon in the North and the Striped Cushaw and Sugar, greenish or grayish, favorites in the South, as typical pumpkins, and the Hubbard and the Mammoth, the former a hard, greenish, warty variety and the latter a huge light colored flattened variety as typical of the squashes. The pumpkin has been grown extensively as stock feed as the fall varieties are more tender and better adapted for the purpose than the squash and this has led many persons to associate the pumpkin as primarily for stock and the squash as more aristocratic and grown for the table. One of the best descriptive articles* of these plants is from the Iowa Experiment Station.

The Bureau of Chemistry in giving an opinion concerning the proper labeling of squash and pumpkin issued the following based upon information from the Bureau of Plant Industry: “All horticultural varieties belonging to the species Curcurbita maxima, Duchesne, are properly termed squash, and the canned product derived from the fruit of this species, should, therefore, be labelled ‘squash.’ However, in view of the fact that the name pumpkin is quite generally used as a popular name for squash, the Department will not object to such designation when applied to the better grade of the species.”

Pumpkin suitable for canning is preferably of a slow maturing variety with a firm texture and a deep yellow color. A light or a greenish shade in the flesh gives a grayish or drab shade to the finished pulp so that it is less attractive to the eye though it may be just as good in every other respect. Those which are soft or coarse and stringy do not work up well in the preparation.

It is better that the crop be grown in the open field as a special crop since the fruit will attain a larger size and ripen more evenly than when grown as a secondary crop in the corn. The yield when grown as an independent crop is often 10 tons or more per acre but is generally not over 5 to 6 per acre when grown as a secondary crop and the average is less. The advantage in the latter is that no additional land nor labor is required to produce it. The pack in 1929 amounted to 2,424,000 cases, of which Indiana produced more than 1,000,000 cases. The average annual production is now nearly 1,600,000 cases.

Harvesting

Harvesting does not occur until late in the fall, generally after frost and then with little protection the fruit can be kept until freezing or until December and thus be worked during a slack period in factory operations. The principal packing is done in New York, Ohio, and Indiana, the last leading by a wide margin. One midwest firm packs more than a quarter of a million cases annually.

In pulling the pumpkins in the field, it is better to leave the stems attached, as breaking them from the fruit leaves an exposed surface which serves as a point for incipient rotting and also souring, and of the two the latter is the more insidious, as it is less likely to be observed by those who do the preliminary selection and is also the more dangerous in causing trouble in the can. Spoilage in fresh pumpkin takes place slowly and particularly so if the weather be cool; trouble may be present in only an

*Casletter, E. E. and Erwin, A. T. A Systematic Study of Squashes and Pumpkins. Iowa Experiment Station, Bul. No. 244.
occasional fruit having the stem knocked off if the packing be done within a couple of weeks, nevertheless, it is bad practice to break the surface and inexcusable to use a fork in handling under any condition. Both pumpkin and squash are sufficiently resistant to withstand any ordinary mishaps in handling from the field in trucks, wagons, cars, or other carriers without crating, and will stand piling to a depth of four feet or more. It is well, however, to follow the best practice of the kraut packers and limit the piles to about ten feet in width and four feet in height in order to permit free circulation of air. It is an interesting sight to see an acre or more covered deep with pumpkins, but, as they are living parts of plants, they need air to carry on their life processes and piling in rows furnishes the better conditions.

**Canning**

The methods followed in the packing of pumpkin have passed through many changes and are still far from being standardized. Instead of the material being kept whole, which is obviously impossible, or in pieces of convenient size as done with most other fruits and vegetables, it is reduced to a pulp and sometimes concentrated slightly to obtain a heavier consistency. The work can be done on a small or moderate scale with simple equipment or in the case of large production by apparatus especially designed for the purpose.

The preliminary operation consists in the selection of uniformly well-ripened sound stock. These are dumped into a large tank of water to soak from 5 to 10 minutes or even longer. The pumpkin is always dirty from contact with the soil and particularly so if there was rain before gathering and the soil clayey. A short soaking makes possible the completion of the work by sprays. In some cases it may be necessary to use hand brushes but the combination of soaking and spraying is usually sufficient and is always better than to depend upon workmen. The stem is knocked off and the pumpkin placed on a conveyor which carries it under a disk that cuts it in two. In small plants the division may be made with a guillotine knife, a large cleaver, or a sharpened spade. The seeds are removed with a hand tool fashioned in the form of a small curved hoe or by means of a special power-driven machine that has revolving paddles designed for the purpose. In some plants the pumpkins are cut into chunks of any convenient size as three or four inches square and are passed through a heavy revolving drum where ninety-five per cent or more of the seeds are knocked out by the tumbling motion. The remainder are thrown out with the waste in the pulping.

If the pumpkin be cut into chunks, it can be done with a sharpened spade probably better than with any other hand tool. A simple power device consists of five or six cutting disks on the same shaft set over a conveyor belt to cut the pumpkin into segments from which they are discharged upon another conveyor running at right angles under another set of disks. An even simpler method consists of an upright chute about eighteen inches square and having two sets of knives at right angles near the bottom. The halves of pumpkin are dropped from a height of ten or twelve feet upon the knives with the result desired.
Steaming

The chunks after being freed from seed are cooked until soft. The method most widely used has been to place the pieces in heavily tinned wire baskets set inside crates in a retort. It is better that the layers be limited to about eight inches but many packers fill the crates to capacity. About five pounds steam pressure is turned on if the pieces be small or of medium size but increased to eight pounds if the pieces be large or thick. The use of pressure insures heat penetration through the mass and within a short time. A low pressure is preferable, otherwise there is darkening and loss of flavor. The time required in the retort will depend upon the size of the pieces but ordinarily from 12 to 15 minutes suffice and in the event it does not, there is the option of extending the time or raising the temperature. In order to get a dry pack the steaming may be done at about three pounds with the large vent on the cover open and the cooking kept up from 25 to 35 minutes. When the steaming is completed, it is well to open wide the retort and as quickly as possible, leaving the crates in place for a short time so that evaporation will produce as dry a product as possible. No records are available but it would seem probable that by driving a moderate blast of air through the retort from the bottom or by applying a low vacuum soon after the steam is shut off that a dry product might be obtained with simple apparatus. The difference between a standard moist pack and a dry pack is only 4 or 5 per cent of moisture and it should be possible to eliminate that amount at this point without difficulty.

If retorts are not available for this preliminary cooking, wooden tanks with covers will answer but with the precaution to have a false floor above the steampipes. As no pressure can be used in this device, the time must be prolonged to from 25 to 30 minutes. The product is more watery with this style of cooking so that the pulp has to be given a short kettle cook to bring it to the consistency expected by the trade.

Tower cookers are used to get a continuous cooking effect. These cookers vary from 8 to 15 feet in height and 2 feet or more in cross section. Hazards are placed on the inside from 18 to 24 inches apart to prevent the pumpkin packing close together. The pumpkin is filled from the top and steam turned in at the bottom. As the pieces soften they work downward where the condensed steam and juice from the pumpkin escapes through a slat bottom. The softened pumpkin is diverted directly to the cyclone, whereas in the cookers previously described, the material is handled in batches. The pulp resulting is intermediate in moisture between that from the retort cooked under pressure and that cooked in the open vat. If operated slowly with low steam pressure so that the pumpkin is softened by cooking and not disintegrated by jets of steam, a very good result is obtained. When operated to maximum capacity, the pulp is not so good and the waste is greatly increased. A tower cooker was patented by Edward E. Brass, No. 1,647,338, November 1, 1927.

In another development for the preparation of pulp, the split pumpkin is run through a special cutting machine built after the fashion of a kraut cutter but the pieces in this instance are about a half-inch square and four inches long, the object being to get the pieces small so that they cook uniformly in a short time. The strips thus produced are cooked in a special cooker built on the plan of a horizontal steam box within which is a series of metal conveyors that carry the pumpkin in a thin layer back and forth
four times and discharge it in a continuous stream ready for the pulping machine. There is no pressure in the steam box but the entrance and discharge are so well guarded that a temperature of 212° F. is maintained. As a supplementary step to get dryness, the pumpkin is discharged upon a conveyor belt and passed under another so that sufficient pressure is exerted by the two to squeeze out some water after which it is delivered to the pulping machine. This equipment, consisting of the cutter, cooker, and press, has a capacity for one line of No. 2 1/2 cans operating at 50 cans per minute. Wiegand gives the time for steaming squash in the Northwest as from one hour to an hour and a half, which is very much longer than in the East.

Pulping

The pulper used for reducing the pumpkin to a uniform fineness is the same as that used for tomatoes and in addition some packers use a finisher. The coarse screen is more nearly like that used in the home, which seems preferable for pies. The finishing machine produces a very smooth but pasty mass which appeals more to the salesman than to the user. If the pulp be watery, it can be put in a jacketed kettle equipped with a stirrer and some moisture driven off. If the temperature be dropped below 160° F. in the pulping, it is better to return the pulp to the kettle to raise the temperature to or above this point and then fill and seal. This is much better than to attempt to raise the temperature by exhausting. Kettle cooked pulp usually has salt added, equivalent to about one-half per cent. Ginger, cinnamon, mace, and sometimes molasses are added by some packers, the product then designated as spiced pumpkin.

Pumpkin has such a vigorous action upon the tin can that it should be hot when sealed and the can be as full as possible. Lacquer-lined cans are used almost exclusively.

Cooking

Heat penetration is slow in pumpkin and particularly so for a dry pack. The time required in cooking, therefore, depends upon the dryness and the initial temperature at which it enters the retort. In experimental work using No. 2 1/2 cans of dry pack, sealed at about 150°, it was found that 90 minutes at 250° was necessary to be safe, while a wet pack, bordering on the line of being sloppy, was sterilized in one-half the time. No means for testing the consistency were available at the time but the dry pack was probably a little heavier than the commercial dry pack.

The cooking schedule now recommended by the National Canners Association is as follows:

<table>
<thead>
<tr>
<th>Initial Temperature</th>
<th>Cooking Temperature</th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 2 1/2</th>
<th>No. 3</th>
<th>No. 5</th>
<th>No. 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>240</td>
<td>70</td>
<td>70</td>
<td>85</td>
<td>95</td>
<td>130</td>
<td>180</td>
</tr>
<tr>
<td>130</td>
<td>245</td>
<td>60</td>
<td>60</td>
<td>75</td>
<td>85</td>
<td>120</td>
<td>165</td>
</tr>
<tr>
<td>130</td>
<td>250</td>
<td>55</td>
<td>55</td>
<td>70</td>
<td>80</td>
<td>110</td>
<td>155</td>
</tr>
<tr>
<td>160</td>
<td>240</td>
<td>60</td>
<td>60</td>
<td>70</td>
<td>85</td>
<td>115</td>
<td>155</td>
</tr>
<tr>
<td>160</td>
<td>245</td>
<td>55</td>
<td>55</td>
<td>70</td>
<td>75</td>
<td>105</td>
<td>140</td>
</tr>
<tr>
<td>160</td>
<td>250</td>
<td>50</td>
<td>50</td>
<td>65</td>
<td>70</td>
<td>95</td>
<td>130</td>
</tr>
<tr>
<td>180</td>
<td>240</td>
<td>55</td>
<td>55</td>
<td>65</td>
<td>75</td>
<td>105</td>
<td>130</td>
</tr>
<tr>
<td>180</td>
<td>245</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>65</td>
<td>95</td>
<td>120</td>
</tr>
<tr>
<td>180</td>
<td>250</td>
<td>45</td>
<td>45</td>
<td>55</td>
<td>60</td>
<td>90</td>
<td>110</td>
</tr>
</tbody>
</table>

Cooking in an agitating cooker is desirable to promote heat conduction.
though the most suitable times to secure sterilization have not been determined. Cooling should follow at once.

TENTATIVE UNITED STATES STANDARDS FOR GRADES OF CANNED PUMPKIN (AND SQUASH)
March 15, 1934

Definition

CANNED PUMPKIN is the canned vegetable prepared from sound, ripe, golden-fleshed sweet varieties of the common field or pie pumpkin by thorough washing, stemming, cutting, steaming, peeling, and reducing to a pulp. The product is packed in hermetically sealed containers, and sterilized by heat.

Grades of Canned Pumpkin

U. S. Grade A (Fancy) canned pumpkin consists of fine, soft pumpkin pulp reduced to a heavy, thick consistency; is uniform in color throughout, and possesses a smooth, fine finish. The product is practically free from particles of seed, rind and fiber, and from other defects; has the typical flavor of well-ripened pumpkin; and scores not less than 85 points when scored according to the scoring system outlined herein.

U. S. Grade C (Standard) canned pumpkin consists of soft pumpkin pulp reduced to a thick consistency; is reasonably uniform in color throughout, and possesses a reasonably smooth finish. The product is reasonably free from particles of seed, rind, and fiber, and from other defects; has a good pumpkin flavor; and scores not less than 70 points and need not score more than 84 points when scored according to the scoring system outlined herein.

Off-Grade (Substandard) canned pumpkin is canned pumpkin that scores below 70 points when scored according to the scoring system outlined herein, or, when any one of the grading factors falls in the subdivision D; or, it is canned pumpkin that falls below any standard for canned pumpkin promulgated under the terms of section 8, paragraph 5, of the Food and Drugs Act.

Prerequisites to Grading

Fill of Container—Cans of pumpkin shall be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container, and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned pumpkin that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

The maximum head space allowable in the sizes commonly used in packing canned pumpkin is shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum Capacity in Water at 68° F. (in ounces)</th>
<th>Maximum Head Space Allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 2½</td>
<td>29.79</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 3</td>
<td>35.08</td>
<td>10.2</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Ascertaining the Grade

The grade of canned pumpkin may be ascertained by considering in addition to the foregoing requirements, the following factors: consistency, color, finish, absence of defects, and flavor. The relative importance of each element has been expressed

---

1 These standards for grades are so framed as to exclude substances not mentioned and in each instance imply that the product is clean and sound.
2 These standards contemplate the use of firm-shelled, golden-fleshed sweet varieties of either pumpkins or squashes for canning. The canned product of either may be graded under these standards.
Numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>I. Consistency</td>
</tr>
<tr>
<td>20</td>
<td>II. Color</td>
</tr>
<tr>
<td>20</td>
<td>III. Finish</td>
</tr>
<tr>
<td>20</td>
<td>IV. Absence of Defects</td>
</tr>
<tr>
<td>20</td>
<td>V. Flavor</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Ascertaining the Rating of Each Factor—The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges, within each factor are inclusive. For instance, the range 17 to 20 means 17, 18, 19, and 20.

I. Consistency—The factor of consistency has reference to the density of the product.
(A) If, when emptied from the can, the pumpkin holds the shape of the can, or holds a high mound formation, the credit of 17 to 20 points may be given for this factor.
(C) If when emptied from the can, the pumpkin is of such consistency that it will pour or tend to level itself with slight separation of free liquor, a credit of 14 to 16 points may be allowed.
(D) If when emptied from the can, the pumpkin is thin and watery with separation of considerable free liquor, a credit within the range of 0 to 13 points may be allowed.

II. Color.
(A) Pumpkin that is uniformly bright, possessing the typical color of properly matured pumpkin, may be given a credit of 17 to 20 points for the factor of color.
(C) If the color of the pumpkin is but fair, or shows slight discoloration from any cause, a credit of 14 to 16 points may be allowed.
(D) If the color of the pumpkin is poor—that is, dark orange or brown, or if the pumpkin is markedly discolored—a credit within the range of 0 to 13 points may be allowed.

III. Finish—The factor of finish refers to the smoothness of the product—that is, the fineness or coarseness of the grain.
(A) Pumpkin that possesses a uniform, well divided, smooth but not pasty finish, may be given a credit of 17 to 20 points for this factor.
(C) If the finish is somewhat grainy but not markedly coarse, a credit of 14 to 16 points may be allowed.
(D) If the finish is poor, a credit within the range of 0 to 13 points may be allowed.

IV. Absence of Defects—Under the factor of absence of defects, the presence of particles of seed, rind, fiber or "string" or other defects are considered.
(A) Pumpkin that is practically free from the defects mentioned may be given a credit of 17 to 20 points for this factor.
(C) If the pumpkin is reasonably free from such defects, a credit of 14 to 16 points may be allowed.
(D) If the defects are decidedly prominent, a credit within the range of 0 to 13 points may be allowed.

V. Flavor.
(A) Pumpkin that has the typical flavor of well ripened, properly matured pumpkin may be given a credit of 17 to 20 points for the factor of flavor.
(C) If the flavor is but fair, a credit of 14 to 16 points may be allowed.
(D) If the flavor is poor, being noticeably bitter or unpalatable, a credit within the range of 0 to 13 points may be allowed.

Label Weights
8Z Short, 7½ ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb.
608  

**APPERTIZING**

3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2 1/2, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

**Composition**

The composition of pumpkin and squash as given by Wiley is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Pumpkin</th>
<th>Squash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>93.39%</td>
<td>88.09%</td>
</tr>
<tr>
<td>Ash</td>
<td>0.67%</td>
<td>1.72%</td>
</tr>
<tr>
<td>Protein</td>
<td>0.91%</td>
<td>0.92%</td>
</tr>
<tr>
<td>Fiber</td>
<td>0.98%</td>
<td>1.04%</td>
</tr>
<tr>
<td>Sugar, starch, etc.</td>
<td>3.93%</td>
<td>8.05%</td>
</tr>
<tr>
<td>Fat</td>
<td>0.12%</td>
<td>0.18%</td>
</tr>
</tbody>
</table>

J. H. MacGillivray (Purdue Agricultural Experiment Station, An. Rept. 1931), found considerable variation in the specific gravity of pumpkin and squashes, from 0.535 for the Connecticut Field variety of pumpkin to 0.738 for the Delicious squash. Pumpkin yielded a larger tonnage of raw stock per acre while the squash gave a larger yield of cans per ton.

C. B. Sayre (New York Agricultural Experiment Station), in trying to find the cause of the difference between western canned pumpkin and New York products made examinations of ten varieties of pumpkins and six varieties of squashes the results of which are summarized as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>In raw material</th>
<th>Moisture in</th>
<th>Penetrometer</th>
<th>Cans per ton</th>
<th>Tons per acre</th>
<th>Cans in</th>
<th>Solids in</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Starch %</td>
<td>Total Solids</td>
<td>Insol. Solids</td>
<td>Cans</td>
<td>Tons</td>
<td>Cans</td>
<td>Solids</td>
</tr>
<tr>
<td>Pumpkins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conn. Field Gill</td>
<td>1.25</td>
<td>7.55</td>
<td>3.50</td>
<td>93.0</td>
<td>23.0</td>
<td>529</td>
<td>15.62</td>
</tr>
<tr>
<td>Orange Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxury</td>
<td>1.55</td>
<td>9.95</td>
<td>4.05</td>
<td>90.2</td>
<td>21.1</td>
<td>789</td>
<td>8.82</td>
</tr>
<tr>
<td>Winter Luxury</td>
<td>1.84</td>
<td>11.3</td>
<td>5.21</td>
<td>89.2</td>
<td>18.5</td>
<td>672</td>
<td>8.42</td>
</tr>
<tr>
<td>Small Sugar</td>
<td>1.54</td>
<td>11.65</td>
<td>5.83</td>
<td>87.8</td>
<td>17.5</td>
<td>594</td>
<td>7.75</td>
</tr>
<tr>
<td>Kentucky Field</td>
<td>1.73</td>
<td>7.32</td>
<td>3.59</td>
<td>90.8</td>
<td>20.0</td>
<td>624</td>
<td>7.60</td>
</tr>
<tr>
<td>Large Cheese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>new strain</td>
<td>1.60</td>
<td>7.95</td>
<td>3.91</td>
<td>89.6</td>
<td>18.0</td>
<td>554</td>
<td>7.32</td>
</tr>
<tr>
<td>Calhoun</td>
<td>1.78</td>
<td>9.46</td>
<td>4.65</td>
<td>90.6</td>
<td>20.0</td>
<td>745</td>
<td>6.80</td>
</tr>
<tr>
<td>Large Cheese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>old strain</td>
<td>3.37</td>
<td>11.40</td>
<td>6.38</td>
<td>89.8</td>
<td>19.3</td>
<td>816</td>
<td>6.72</td>
</tr>
<tr>
<td>Golden Oblong</td>
<td>2.19</td>
<td>12.20</td>
<td>6.35</td>
<td>89.6</td>
<td>18.6</td>
<td>541</td>
<td>4.80</td>
</tr>
<tr>
<td>Ohio Cheese</td>
<td>3.38</td>
<td>11.41</td>
<td>6.69</td>
<td>91.6</td>
<td>23.1</td>
<td>604</td>
<td>3.32</td>
</tr>
<tr>
<td>Squash</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boston Marrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Gill)</td>
<td>0.21</td>
<td>11.72</td>
<td>2.60</td>
<td>91.6</td>
<td>23.9</td>
<td>431</td>
<td>9.40</td>
</tr>
<tr>
<td>Warren</td>
<td>3.06</td>
<td>11.95</td>
<td>6.73</td>
<td>88.7</td>
<td>19.5</td>
<td>724</td>
<td>9.12</td>
</tr>
<tr>
<td>Boston Marrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robinson</td>
<td>0.72</td>
<td>11.96</td>
<td>4.12</td>
<td>89.1</td>
<td>20.6</td>
<td>620</td>
<td>8.07</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>5.11</td>
<td>14.37</td>
<td>9.21</td>
<td>85.9</td>
<td>15.7</td>
<td>1320</td>
<td>7.55</td>
</tr>
<tr>
<td>Delicious</td>
<td>9.00</td>
<td>22.58</td>
<td>16.75</td>
<td></td>
<td></td>
<td>595</td>
<td></td>
</tr>
<tr>
<td>Golden Hubbard</td>
<td>11.25</td>
<td>21.78</td>
<td>18.34</td>
<td>83.7</td>
<td>12.5</td>
<td>862</td>
<td>5.28</td>
</tr>
</tbody>
</table>

It would be difficult to compress more information with respect to varieties, yield per acre, and yield in cans per ton.

E. H. Wiegand, Oregon State Experiment Station, in calling attention to the difference between Western and Eastern pumpkin, points out that this is almost wholly due to the difference in starch content. Horticulturists have been producing hybrids with a lower starch content and obtain a
canned product more nearly like that packed in the East. This is considered better than trying to obtain the same consistency by blending varieties.

As previously indicated, the action of pumpkin upon the plain can is violent by comparison with most vegetables, causing the whole of the inside to be darkened, the pumpkin becoming a grayish color where in contact with the can and acquiring a distinctly metallic taste. The action can be lessened by filling the can as full as possible with hot pulp, cooking quickly and cooling to air temperature promptly. Storage in a cool warehouse is also advantageous. The use of C enamel cans only partially corrects the difficulty but are very much to be preferred to the plain. Perforation of the metal is no: common.

**Waste**

The seeds with the attached fiber are run through a squirrel cage washer and sprayed with water which effects a separation of the seeds. The fiber and the discharge from the pulpers may be used advantageously as stock feed but there is no economy in drying them. The seeds are dried.

**RHUBARB**

*Rheum rhabonticum*

Rhubarb, a common garden plant in this country, also known to many persons as pie-plant or wine-plant, is a native of the Volga region of Russia and of the country eastward into central Asia. It has been known for a long time as a medicinal plant, the root having been obtained from the north by Greeks and Arabs and distributed in commerce as a valuable drug to be used as a purgative and general body corrective. It was introduced into the gardens of some of the herbalists in Europe probably during the last half of the 15th century and shortly after into England. It was in this latter country that the use of the leaf and stem as a food received its greatest impetus. In Queen Elizabeth’s time the leaves were used as a pot-herb and were preferred to those of the spinach or beet. With the change in cookery the leaf-stems were used in tarts, sauces, and jam, and the expressed juice in wine and through these uses originated the terms pie-plant and wine-plant.

The English showed much more fondness for the plant than did the people of the continent. They cultivated it in kitchen and market gardens and bundles of stems were sold at the stalls and hawked upon the streets as something extra fine in the spring of the year. Their horticulturists developed better strains of stems with more delicate flavor and with a pinkish color. They also protected the new growth from sunlight so as to get extra length and etiolation of the stems, the product thus prepared being especially esteemed and commanding a high price. Rhubarb is used in northern Europe but only sparingly as compared with the amount in England. It is almost unknown in the central and southern part.

The introduction of the plant into this country was by English immigrants and no doubt part of the traditions concerning its use and its popularity had its origin from the same source. It has found such favor here that carloads are sent by express from the West Coast to eastern markets in the spring before the local crop or other fresh products suitable for pies
or sauce are available. The composition of the stem is said to change but little during the season, though probably more than ninety per cent of the consumption takes place before the middle of June.

The Plant

The plant is a striking perennial, has very large broad, fleshy leaves and long, thick, succulent stems. The flowering stalk is branched with numerous small, whitish or greenish, inconspicuous, individual flowers. It grows to a height of about four feet and the leaf and its stem to two and one-half to three feet. The root system is large and coarse and contains a large reserve food supply which the plant draws upon in making rapid spring growth. It is a gross feeder so needs a rich loam that is moist but not wet. Fields for a canning crop are usually laid out in rows four feet apart and the plants two feet apart in the row. It is not an important canning product, the total pack amounting to only about 50,000 cases annually. The principal points of production are in Washington, Oregon, New York, and New Jersey.

Harvesting

Harvesting for canning is done later in the season than for the fresh market, most often from June until August, there being no particular period that is better than another while the stems are succulent. Only the largest and best stems are selected, the others being left to maintain the plant growth. The stem is jerked off the root, then trimmed of the leaf and any undesirable material at the base. They are generally handled from the field in crates or lug boxes.

Canning

At the factory the stems are given a close inspection and trimming, then washed and cut into lengths of about one-half or five-eighths of an inch. Some packers cut to three-quarters or one inch but this is rather coarse and especially if the stalk be large. The cutting may be done on a string bean cutter or by an improvised cutter made of a number of disks spaced on a shaft and set across a conveyor belt or drum. The stems are fed crosswise. They are peeled only when a strictly fancy pack is to be made.

Formerly the cans were filled with the cut pieces, boiling water added, the cans sealed at once, and cooked in an open bath for 10 minutes for the No. 2\(\frac{1}{2}\) and No. 3 sizes and 20 minutes for the No. 10. No trouble was experienced from spoilage due to lack of sterility as rhubarb is easily kept, but upon opening the cans, the pieces were so badly collapsed that the contents presented the appearance of being slack filled, the metal on the inside of the can showed corrosion, and the contents had a marked astringent metallic taste. Springers and swells were common after a few months, though pinholeing was less frequent than with many fruits. Inside lacquer provided little protection as that coating loosened in shreds. Under such conditions little progress was made in developing a product acceptable to the trade. The difficulty in packing was believed to be due to the high acidity and the nature of the acid.

The first step in the improvement of the pack was to cook the rhubarb in a kettle with from 20 to 30 per cent of sugar and either without any water or only sufficient to start the cooking. This has the effect of collaps-
ing the material and at the same time adding a part of the sugar necessary for its final preparation. The amount of rhubarb required to fill the can is as 8 to 5 over the older method, or nearly double the amount. The sugar serves to give a firmer and better appearance as well as to correct the excessively acid taste, and in addition, the cans show a much better fill on the cut-out.

Cooking in the kettle is conducted below boiling, or about 185° F., and continued from 10 to 12 minutes. It has a double effect, that of eliminating air and gases from the tissues and combining with the sugar, both of which lessen can corrosion so that the development of springers and swells is delayed some months though not wholly prevented. Since rhubarb is used chiefly in pies, tarts, and sauce where the whole appearance of the stem is not of first importance, this style of packing is probably best adapted to give the maximum quantity in the can, which in the long run is most profitable to both packer and purchaser.

A method of packing in which the cut rhubarb is soaked in cold water or in very weak brine is a direct outgrowth of a similar method of packing apples. The object is to displace the air or gas with water and thus reduce the chemical action between the product and the metal of the can. The soaking is generally done over night or from 12 to 16 hours. The rhubarb is given a short hot water blanch, about one and one-half minutes, filled into the cans warm and hot water added. If the center of the can is above 125° F., no exhaust is given, otherwise the cans may be exhausted or sealed in vacuum. The cook is most often 12 minutes for the No. 2½ cans and from 25 to 30 minutes for the No. 10 size.

Inside enamel cans are used for this style of packing and little trouble is experienced with springers or swells within one year. The rhubarb collapses less than in kettle cooking so that the yield per ton of raw material is greater but more shrinkage occurs at the time of final preparation so that nothing is gained and there is added cost for both cans and freight.

The role of air in causing the unusual corrosion of cans containing rhubarb and the importance of eliminating all of it, even from the tissues, was first determined by E. W. Clough and E. D. Clark in 1925. Prior to that, the corrosion was believed to be due to the acid present but their work established the acid to be another factor.

Glass is the better container as in it the rhubarb retains its natural flavor.

**Label Weights**

<table>
<thead>
<tr>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syrup 20° cut-out</td>
<td>8Z Short, 7 ozs.</td>
</tr>
</tbody>
</table>

**Composition**

Rhubarb has a very low food value and its use is almost wholly due to its peculiar agreeable tartness that gives relish to other foods. However, late in the season, the leafy portion may become so heavily saturated with oxalates that poisoning may result from their use, a condition which does not apply to the stems.
The composition as given by Wiley is as follows:

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>92.67</td>
</tr>
<tr>
<td>Ash</td>
<td>.94</td>
</tr>
<tr>
<td>Protein</td>
<td>.83</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.11</td>
</tr>
<tr>
<td>Sugar, starch, etc.</td>
<td>3.26</td>
</tr>
<tr>
<td>Fat</td>
<td>1.19</td>
</tr>
</tbody>
</table>

As given in Circular No. 50, Department of Agriculture:

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse</td>
<td>32.</td>
</tr>
<tr>
<td>Water</td>
<td>94.9</td>
</tr>
<tr>
<td>Protein</td>
<td>.5</td>
</tr>
<tr>
<td>Fat</td>
<td>.1</td>
</tr>
<tr>
<td>Ash</td>
<td>.72</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>3.8</td>
</tr>
<tr>
<td>Fiber</td>
<td>.7</td>
</tr>
<tr>
<td>Sugars</td>
<td>.4</td>
</tr>
<tr>
<td>Calories, per 100 grams</td>
<td>18.1</td>
</tr>
<tr>
<td>Calories, per pound</td>
<td>80.</td>
</tr>
</tbody>
</table>

**SALSIFY**

*Tragopogon porrifolius*

This plant is native to southern Europe and while known from ancient times, it was not used commonly or at least not cultivated. It was not until as late as 1600 that it is mentioned as a new cultivated garden plant in France though its use in Italy was anterior to that time.

The plant is a hardy biennial, grows to a height of 2 to 3 feet, the leaves long and narrow, grass-like, the flowers small and bluish. The root is about a foot long, from 1 to 2 inches in diameter at the top and tapering and closely resembles that of the parsnip but has more side branches. It requires a full year to develop. It is white, sweet, tender, and has a distinctive flavor strongly suggestive of the oyster due to which it is frequently given the name oyster plant. It has considerable usage in Europe but is not very well known here.

There are only a few varieties. The plant is one which is practically free from either insect attack or plant diseases, and can be cultivated on any deep loam so that the roots may penetrate without being distorted. The seed is drilled in rows about 2 feet apart and spaced 6 inches in the row.

The canning of salsify is more difficult than most root crops, especially when an attractive appearance is desired. It is therefore packed as a novelty or reserved for home canning. Only the medium sized roots are selected as the small ones require too much labor and the large ones are almost sure to be fibrous and not very attractive upon being cut. The root is left whole or cut to the length of the can. Immediately upon scraping, it is submerged in a 3 per cent salt brine and for as short time as possible. It is blanched in a bath containing vinegar, equivalent to one-half per cent acidity or slightly more. The blanch is continued from 8 to 10 minutes, then the roots given a thorough washing, and at the same time kept well submerged in the water. The cans are filled and a 1 1/3 per cent brine added. Citric acid can be used in the bath though it is not as effective as the vinegar.
Spinach or spinage is known botanically as *Spinacia oleracea*, one of the few cultivated species of the family Chenopodiaceae. The plant has been known for a long time, though under cultivation for only a short period by comparison with many others. Another plant, *Tetragonia expansa*, has recently been introduced as Summer or New Zealand spinach. The latter is in no way related to the true spinach, but confusion sometimes occurs and is likely to become more frequent, due to the dropping of the modifying term. The resemblance of the plants is fairly close, but the newer plant is used only during the summer or warm weather when the true spinach is not acceptable. Furthermore the plant has the distinction of being the only vegetable contributed to the market garden by New Zealand.

The home of spinach is not known with certainty. According to De Candolle, it was unknown to the Greeks and Romans and to Europe prior to the 16th century. It is listed as occurring, though not common, in southern Europe in 1568. Works upon cookery, however, indicate earlier usage of the plant. Its home is believed to be Persia or west central Asia and as far north as the Caucasus Mountains. The name has been traced back into the Arabic and Hindustani languages, but not into the Sanscrit.

The plant has been cultivated for about three hundred and fifty years. It was generally looked upon as a novelty to supply early spring greens, but recently has become popular here, supplanting in a large measure the dandelion, mustard, beet tops, kale, and sorrel, in the fresh market. It is so easily grown and yields so abundantly that the labor is even less when planted in the kitchen garden than that of wandering over fields for other plants in early spring, and the flavor is more agreeable to most persons. It was grown as a staple garden crop from Hindustan in Asia, westward through southern and central Europe, and was brought to this country by immigrants and also carried to South America and the islands of the Pacific. D. Landreth Co., prominent seedsmen, claim to have introduced the Bloomingdale or Norfolk Savoy variety in 1826, which has been, and still is, the most used home and market garden variety.

**Growth in the Use of Spinach**

The use of spinach in this country is of recent date. The Department of Agriculture featured the distribution of seed by members of Congress in the nineties, and thus made the plant known to many persons, whereas prior to that time it was known to only a few, though its preparation is described in nearly every early cook book. It is now grown commonly by market gardeners in the central and eastern states to supply the heavy demand from the cities for early spring greens, and by southern gardeners for late fall and winter shipments, and is becoming a staple in home gardens. It is grown extensively in California for canning. Prior to 1918, there were only a few references to the plant in the *Experiment Station Record*. As that publication abstracts all work published from the state experiment stations and notes important work from other sources, it may be accepted as reflecting the interest taken in this garden plant. The marked increase in its use during the past two decades may be ascribed to the teaching of dietetics.
in the public schools and to home-makers. The beneficial effect of certain foods upon health in general has been emphasized independently of their rated food values. Spinach has been advocated primarily as a source of soluble mineral constituents, especially iron, but more recently as being a rich source for some of the vitamins. Its growth in popularity is well reflected by the amount which is canned, though doubtless in a lower ratio than in the use of the fresh product. The date of its first canning in this country has not been obtained, as there is scant reference to it prior to 1900. Some canning was done in Maryland, New Jersey, and New York in 1904; the total pack for the entire country was small but gradually increased with succeeding years. The statistics for 1914, the first that are available, show the following pack: California, 23,755; Maryland, 282,795; New York, 52,596; Ohio, 15,450; all other states, 17,194; total, 391,790 cases. The increase is shown in the 1919 pack, which was 477,000 cases; 1921, 677,-000; 1923, 1,875,000; in 1925, 2,045,000; 1927, 2,462,000; 1929, 4,815,-000, and 1931, 2,796,000 cases respectively. An increase of more than 500 per cent in the use of one pot-herb within a period of ten years is phenomenal and this does not include the increase of the fresh plant in the vegetable markets. The favorable weather conditions for winter growing an average yield of double that per acre in the East, a cost of only one-half to two-thirds as much per ton, have been the contributing factors to the shift to the West.

The Plant

Spinach is an unattractive weedy looking plant, a semi-hardy annual which stands moderate freezing so can be grown from fall seeding as far north as Maryland and New Jersey, if given a light protective covering during the winter. The plant grows from one to two feet high, has succulent leaves which generally number from six to twelve, and form a close cluster about the stem. The leaves start from the stem from one to three inches above the ground, and in some varieties, like the Savoy, are fairly erect or form lettuce-like heads, while in other varieties, like the Prickly Seeded, they tend to turn downward or droop. The leaves are rather triangular or arrow-shaped, and measure about four and one-half inches across the base to six inches in length for the fairly large leaves. In some strains the tip of the leaf and the expanded portion at the base are broadly rounded, while in other strains they are distinctly angular. The leaf is dark green, not very thick, tender, and has a petiole from three to eight inches long. The flowering stalk rises from the center and bears inconspicuous flowers. The plants are male and female, the former bearing small green flowers in terminal spikes, while the female are axillary clustered. The seeds are smooth in some varieties and prickly in others, the latter giving rise to the term “prickly seeded,” as though it were the characteristic of one variety, whereas it was this characteristic which gave the name to the species.

There are a number of varieties of spinach, but the differences are not well fixed, due to the plant not having been bred through continuous selection to definite types to reproduce the qualities with certainty. The Savoy, Norfolk Savoy, and Round Seed Savoy are very nearly the same, and represent the most nearly fixed type. The leaves are slightly wrinkled and stand clear of the ground. This type is preferred by the market gardener
as it has the advantage of holding its form best during handling and shipment. The Prickly Seeded and Prickly Winter represent the thin flat type, and are the ones most used for canning, especially in the West. An attempt has been made to increase the yield by developing strains of this type with thicker leaves, and this result has been accomplished in some measure in the Thick Leaf Winter Viroflay, and a half-dozen others, varieties scarcely distinguishable from these. Long Standing is a term applied to flat leaf spinach in a very indefinite way, the same as prickly seeded. One variety, said to be the true Long Standing, is a very slow growing sort, and does not yield well. It is used to a limited extent to extend the canning season, as it develops after other varieties have matured, but is so late that it is apt to be attacked by insects. Nearly all of the seed was formerly imported from Holland but domestic supplies are now available.

The planting is timed to produce the principal growth late in the fall or early in the spring, during cool weather, as growth which takes place during the hot weather causes the plant to be tough and fibrous and lacking in other desirable qualities.

Spinach for Canning

This monograph will give consideration only to such problems of production and handling as are connected with the operations of a cannery and to canning technique and not to growing and preparing the plant for the fresh market or the home.

Spinach was one of the plants used by Appert in his original experiments on canning so that the method of preparation dates to the beginning of the art. There is no record, however, of any practical or commercial use of the method in the early years, as the high cost of canning made it necessary to use only the more valuable products. It is not possible to trace the beginning of the canning of this product in this country from the meager records which have been published. Its real development here has been since 1900, proceeding first along empirical lines but is now a nearly standardized operation. Most of the progress has been made within the past twenty years and under duress. The pendulum has probably swung from the extremes of under-treatment to over-treatment in the different processes, and is settling to more nearly proper limits. A few men have made contributions to factory equipment and in the better preparation of the product, but no comparative studies have been made to determine the actual efficiency of many things which are done, nor their cost.

Spinach grown for canning purposes is planted in rows from 15 to 20 inches apart and the plants about 8 inches apart in the row. In the West the planting is done from the latter part of October until the middle of December, the object being to have the crop mature over a period of several weeks, so as not to have a glut by a short period of harvesting. The period for maturing is from the latter part of February to the middle of April and does not necessarily correspond with a definite time of planting, but is influenced by the temperature and moisture in the spring. If the temperature remains cool, then the harvest may be prolonged to correspond with the planting; if it turns warm, then the last planted fields may mature as soon as those which were planted earlier, a condition similar to that in the packing of peas in Wisconsin. In the East the spinach is planted as
soon as the ground can be put into good condition in the spring, with the consequent harvesting occurring in May or early in June.

The crop is grown in rows as it is necessary for proper cultivation and suppression of weeds. The presence of the latter adds greatly to the cost of sorting in the field or in the factory. It is a crop which requires considerable hand labor, whether intended for the market or cannery. In the East, if the ground be very clean, the crop may be sown broadcast and harvested with a low-cutting mower. The yield of spinach is given as from 3 to 6 tons, with an average of 4 tons for the West, and from 1 to 3 tons with an average of 2 tons, for the East. The large yields of 10 tons or more are counter-balanced by the acres which are not harvested. The average price per ton in the West is around $15, while in the East it is $22.

Harvesting

The harvesting is done when the plant shows evidence of developing the flowering stem. If the cutting be done too early, the yield per acre is lowered, and furthermore the leaves show excessive shrinkage and softening during preparation; if delayed too long, the plant becomes fibrous and with accompanying changes until it loses its distinctive quality. The cutting is done by means of a horse-drawn tool having one or two flat blades which cut one or two rows at a time at or just below the surface of the ground. The plant must be cut below the juncture of the leaves with the stem, otherwise there is waste. When two rows are cut at the same time, they are turned toward each other to facilitate gathering the plants. If the field be weedy or the patch be small, the cutting may be done with a scuffle hoe or a large knife. Some attempts have been made to use low-cutting mowers with gathering platforms, but without complete success. The machinery for doing this work has not been developed to the point of saving labor and handling the product well. Hand pulling is resorted to in some cases if the soil be loose and friable.

The carting of spinach from the field to the factory is not standardized in the East, but may be done either by forking the cut plants on flat-topped wagons, similar to the method for pea vines, or be picked into barrels, tomato crates, or baskets. In the West all spinach is hand-picked into crates designed especially for the purpose. In the hand picking the weeds and defective plants are sorted out, thus reducing the weight, waste at the factory, and some labor, all of which count when payment is made upon the basis of the gross weight. The crates are in three sizes for 80, 60, and 40 pounds capacity. The 80-pound crate is too large and heavy for one man to handle easily, with the result that the harvesters drag the crate instead of lifting it, and press an excessive quantity of plants in the crate which tends to cause heating in the mass. The 40-pound crate is so small that it necessitates handling too many. The 60-pound crate seems to be a good compromise, and the indications are that it will supplant the other two as replacements are made. The advantages of the crate system of handling are obvious. The spinach is not crushed, can be handled in larger loads on the truck, and hauled farther without injury; it can also be held longer, and handled through the factory with the minimum of labor. In addition, it affords a check on the care in harvesting, on the amount of waste delivered, and in the promptness with which delivery is made after cutting.
The 60-pound crates are 28 inches long, 24 inches wide, and 16 inches high, outside measurements; they are carried one inside of two facing each other when empty. The filled crates are stacked four high, three wide, and make eight tiers, or 96 to the truckload. Thus the gross weight of a load is about 7,500 pounds and the net weight of spinach about 5,700 pounds.

Owing to the succulence of the leaf and the large exposed surface, best results are obtained when the plant is harvested and delivered to the factory promptly for immediate packing. Theoretically it is best that the harvesting be done in the early part of the day, while cool, and the canning be done by evening. Spinach which is cut while cool and dry and packed close in the crates holds its initial temperature for a reasonable time without serious damage, as may be observed by that obtained on the fresh vegetable market and as seen in factory deliveries. That cut in the middle of the day, or while warm, is likely to be from 15 to 20 degrees higher in temperature, so wilts rapidly, thus favoring spoilage. It is better to let the early cut spinach stand until the close of the day and care for that which arrives in a warm condition, though the usual practice is to work the material through in the order of its receipt. A delay of a few hours may cause more loss to warm spinach than to cool spinach which is allowed to stand for a half day or over night. If spinach be received at a factory in a cool condition and cannot be handled at once, it is well to stack the crates close together to preserve the low temperature, but if it be brought in warm, then it is advantageous to stack them with alleys between each row to permit circulation of air. Tests made by placing thermometers in crates filled with spinach below 55° F. showed a slow rise of temperature to that of the outside air, whereas in crates filled with spinach about 75°, there was an increase of 10° or more, in the course of a few hours or during the night, and shortly thereafter there was more or less sliminess or stickiness. Cool spinach will show less change in three or four days than warm spinach which is held over night. Many times it is more economical to increase the field cutting force in the early morning, or while cool, rather than to have a fewer number working throughout the day. This insures both a saving in labor in the factory and in wastage which more than compensate for the increased effort in getting the material in its prime condition. The relationship between the temperature of spinach when cut and the ensuing spoilage is such that no time should be lost in getting the cut material into the crates and to the factory before wilting. First quality in the canned product can be produced only from material in which no changes have taken place in the tissues. Market spinach, which probably averages from two to four days old, produces only a fair quality for canning and that attended by a large wastage of material.

Even though the weather be cool and no spoilage occur, there is the inevitable loss on standing. In one test in which more than a thousand crates were used, the spinach run through the factory as delivered, the waste was 36 per cent, and from a like number of crates from the same field but held over night, the loss was 47 per cent. In addition, the extra labor involved in preparing the second part amounted to 7 per cent. In several tests in which less amounts were used, the figures varied, sometimes showing a greater difference, sometimes less, but in all cases a greater loss of material and increased labor in the preparation of that which was held
than in that packed promptly. The difference in labor is the most difficult factor to determine as there is always some slowing down on the part of the trimmers late in the day and an acceleration on the start in the morning, so that the carry-over material was handled at the most efficient period.

U. S. Grades for Fresh Spinach for Canning

U. S. No. 1 shall consist of spinach which is free from decay, grass, weeds, yellow leaves, roots, and worms, and from damage caused by mildew, seedstems, seedbuds, coarse stalks, wood, muck chips, insects, dirt, or other foreign material.

In order to allow for variations incident to proper handling, the following tolerances shall be permitted for grade defects:

For decay, grass, small weeds, and yellow leaves, not more than fifteen (15) pieces are permitted in a one hundred (100) ounce sample.

For damage by wood, muck chips, or other hard foreign material, no tolerance is permitted.

For roots, large weeds, and damage by mildew, seedstems, seedbuds, coarse stalks, insects, dirt or other foreign material, not more than five (5) ounces are permitted in a one hundred (100) ounce sample.

No tolerance is permitted for worms.

U. S. No. 2 shall consist of spinach which meets all the requirements of U. S. No. 1 grade except that the following tolerances shall be permitted for grade defects:

For decay, grass, small weeds, and yellow leaves, not more than forty (40) pieces are permitted in a one hundred (100) ounce sample.

For roots, large weeds, and damage by mildew, seedstems, seedbuds, coarse stalks, insects, dirt, or other foreign material, not more than ten (10) ounces are permitted in a one hundred (100) ounce sample.

No tolerance is permitted for worms.

U. S. No. 3 shall consist of spinach which is free from worms and from damage caused by mildew, decay or insects.

A tolerance of 25 per cent, by weight, shall be permitted for spinach which fails to meet the requirements of this grade but no part of this tolerance shall be allowed for spinach which contains worms.

Unclassified shall consist of spinach which does not conform to the requirements of any of the foregoing grades.

Trimming

In the trimming of spinach, the plants are handled separately, the leaf stems being cut so that every leaf is detached, or only two or three of the smaller ones remain united. In the East, the leaf stems are cut short so as to avoid any appearance of coarseness; in the West, the custom is to leave them long. All coarse stalks, flower stalks, yellow leaves, defective and foreign materials are removed in this operation, as there is little opportunity to do so at any subsequent time. This difference in the practice in trimming is more far-reaching than merely the length of leaf, stem or stalk that is consumed. In leaving the stem long, many stems are not recut after the harvesting and all stems cut in the field tend to collapse, and in this and in the wilting of the leaf any dirt or sand on the end is drawn inside to the distance of an eighth to a quarter of an inch or even more. Therefore, long stemmed leaves often have grit present from this cause, which cannot be gotten rid of by washing. This is one of the objections to the use of a mowing machine or any other which cuts the spinach above the ground, or rather above a point where the leaves arise from the stem. The pulling method of harvesting is based upon the avoidance of grit in spinach and it can be averted in this way more easily than by attempting to trim the leaf stem when the harvesting is done by cutting.
Spinach is peculiarly free from insect pests, but after a moist spell and in warm weather small worms may make their appearance. These are of a pale green color and so difficult to see that no amount of inspection finds all of them. They can be loosened under strong sprays of water in the flotation system of washing, and fortunately are so heavy that they sink. When the larvae make their appearance, the better factories make hourly inspection of samples from the crates or washer. If any larvae are found to pass the washer or are found in cans, then the operations are stopped.

The usual procedure in trimming is to set a crate on end on the table in front of the trimmer who puts the prepared material in one lug box and the waste into another. The waste will vary from 33 to 50 per cent, depending upon the stock and the amount of care used in picking it in the field. If the spinach becomes advanced or is held longer than usual after cutting, it may be sorted into two grades, the first containing only green tender material and the second that which is off-color, badly wilted, or tough. Most of this work is done by the trimmers, so that finally whether the product be fancy or standard depends in a large measure upon the work at this initial stage.

Another method is to dump the boxes of spinach on a wide inspection belt which is divided into three sections. The untrimmed material passes on the outside and the trimmers on either side deposit all the trimmed material upon the central portion of the belt which carries it in front of inspectors to the washer. Fewer persons do the work than when boxes are used and the resulting material goes at once to the washer in a steady volume.

More or less soil adheres to the base of many plants, and this causes the tables and floors to become dirty. Spinach collected after a rain is one of the most objectionable products which comes to the factory, as it is difficult to keep tables washed and clean.

The use of the inspection belt leading to the washer is one of the more recent additions to the equipment and provides an opportunity to catch material which has escaped the trimmers, and, where boxes are used, to check up on the work of the individuals. Furthermore, the breaking apart of the spinach for inspection insures a more even feed to the washer, a desirable end in itself.

Washing

The washing of spinach is a more difficult operation than that for most vegetables. The leaves are thin, flat, and tend to fold upon themselves, and to mat with others so that the spray does not reach all parts equally well. There is always contamination with soil and dust, which become more or less adherent, owing to the nature of the surface of the leaf. Remaining in the crates after wilting increases the adhesion of the fine particles to the leaves. The only solution for this condition is an abundance of water, a part at least in the form of sprays under pressure. No other product requires an equal volume of water, the nearest approach being peas, and these require only about one-third as much per case. Many special washers have been devised for handling spinach, but nearly all may be reduced to two types or a combination of the two, the rotary drum and the tankwasher with sprays. No meter tests have been made upon the water used in the different types of machines, but estimates based upon pumping capacity place the amount at from 20 to 50 gallons per case.
The earliest washers consisted of a series of tanks, five, six, or even more in a row. The trimmed spinach was dumped into the first, and, after a brief soaking, was worked up and down between the hands and tossed into the next tank, where the same operation was repeated and so on through the series. This was not only costly but unsatisfactory. The next step was to use a wire squirrel-cage made to rotate in a tank. It was filled and discharged as a batch and not continuously, but was the logical step toward the drum washer with inside sprays and continuous feed and discharge. The squirrel-cage used for washing peas was not satisfactory, as the meshes became clogged and the spinach rolled over in the bottom without separation of the leaves. The later drums have been improved with flights to carry the spinach, with sprays directed so that the spinach cannot pass in bunches, and the water pressure and volume made adequate to do effective work. The friction of the leaves with the drum and with each other materially assists in loosening any sand or grit. The objection most often made to this type of washer is that it is rough in the treatment of the product. Its efficiency depends upon a large volume of water having twenty pounds or more of pressure, preferably between forty and fifty pounds, and uniform feeding within its capacity. Dumping spinach in bunches at intervals instead of feeding in a steady stream is responsible for much of the poor work.

Drum washers are ordinarily from 20 to 22 feet long and 36 inches in diameter. They are rated as having a capacity of from 2 to 6 tons per hour. Pre-washer feeders, with paddles to break up the bunches, afford a short soaking, and produce even feeding and are sometimes added, but increase the length by 12 to 15 feet.

The flotation type of washer consists of a long tank with a wire mesh conveyor 8 or 10 inches above the bottom and a foot above this point a large pipe with cross arms and spray nozzles. The water in the tank is maintained six inches or more above the belt, which in reality acts as a perforated screen for allowing dirt to fall to the bottom. The spinach is carried through by the action of the sprays, which separate every leaf, turn it over, and strike every part with sufficient force to cleanse without breaking. The fact that the material is floating in water makes it possible to use a spray pressure of 30 pounds or more. The volume of water is much greater than is used in the rotary drum, and in order to conserve it a part is filtered and reused. The pressure is maintained by means of an auxiliary pump. The final washing is in fresh water. The same precautions with respect to uniformity of feeding and keeping within its capacity apply as in the case of the drum washer.

The finest development of this type of washer consists of a tank divided into two sections, the first about 30 and the second about 15 feet long, with a washing discharge about 10 feet long. A total of 180 nozzles direct the water upon the spinach.

A combination of the drum and tank systems is in use, as well as some special devices, the details of which are not disclosed.

Whether spinach is clean as it comes from the washer cannot be told by direct inspection, as the leaves remain bright and green while there is a layer of water on the surface. Two tests are necessary, one to take leaves and spread them on a clean surface in the sun to dry, the other to empty
the contents of a can of spinach in a white dish or glass bowl. The first test is for fine clay or adobe, which shows as a greyish film on the surface of the leaf upon drying. In the second test the spinach is forked over and lifted out of the dish, then the liquid poured off gradually so as to reveal the presence of sand, if any be present. In 1912, Duckwall called attention to the fact that oxalate of lime crystals may form in spinach and give a gritty sensation when eaten and be mistaken for sand.

Spinach gains considerable weight in passing through the washer, due to the adherent water. As water cannot enter through the surface of the leaf, and the time taken in the washer varies from less than one minute to two minutes, one can disregard the small amount which would be taken through the petiole. In five experiments in which approximately 200 pounds each of spinach were weighed just before and after coming out of the washer the gain was exactly 25 per cent.

### Blanching

Blanching of spinach is necessary to effect a reduction in volume so that a reasonable amount can be filled into a can and also to drive out the air or gases which may be present in the tissues. The stems being hollow, hold considerable air unless completely collapsed. Blanching has less to do with cleansing than in the case of some other vegetables. The usual method of blanching in this country, and also abroad, is to submerge the spinach in hot water at or near the boiling point. The tissue cells in the leaf are large and have a high water content so that sudden high heat has the effect of expanding and causing many cells to be ruptured, with escape of the liquid portion and its soluble solids. The succulent leaf corresponds in many respects to the raspberry and blackberry, which if dipped into boiling water shrink quickly and toughen, whereas if dropped into hot water at 170° F. can be raised close to the boiling point with only a fraction of the injury. It is clearly not desirable to abstract the cell sap with its solids to be replaced with weak salt water if it can be avoided. From the foregoing facts the writer suggested in an earlier monograph that it seemed a more logical procedure to blanch at a lower temperature for a longer time.

The general practice in blanching varies the time from one and one-half to six minutes in water varying from 185° to 210° F. The water at the entrance of the blancher is generally at a lower temperature than at the center and discharge end, owing to the water carried in on the leaves, which in this case serves a good purpose. A precook of less than two minutes at or near boiling does not wilt all parts uniformly nor expel all gases, so that cans do not show uniformity of fill in passing through the exhaust box as the contents expand, rising above the top of the can, thereby discharging some of the brine. After sterilizing they show irregular and often excessive head space with a weak vacuum. Spinach blanched more than three minutes at boiling shows more or less breaking down with a tendency to become mushy, particularly in very tender stock. The overflow from the blancher shows more solids, but as no trouble occurs in the exhaust box from expanding spinach, the fill of the can and the vacuum may be regulated to a nicety. In some experiments carried on with blanching at 170° to 175° F., it was found that the time needed to be practically doubled over that required at boiling, but that the appearance of the product was distinctly im-
proved. The filling in weight and the cut-out weight were affected, but easily adjusted.

**Thomas Patent**

Patent No. 1,685,511, September 25, 1928, issued to W. E. Thomas, Oakland, California, contains the following:

The invention relates to a process for preparing vegetables for canning, and particularly to a blanching or wilting step thereof as applied to chlorophyll containing vegetables such as spinach.

An object of the invention is to provide a process of the character described whereby a maximum retention of the natural color of the vegetable may be assured in the final product.

Another object of the invention is to provide for the blanching or wilting of the vegetable in such a manner as to produce a minimum effect on other qualities of the vegetable than the color and turgidity thereof.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention. It is to be understood, however, that variations in the showing made by the said description may be adopted within the scope of the invention as set forth in the claims.

In the preparation of vegetables for canning, it has long been the practice to subject certain vegetables to the action of boiling water or steam until a desired degree of blanching or wilting has been effected. Though the wilting of the vegetable to reduce the bulk and air content thereof is a major purpose of the treatment, certain other effects are produced by this step which have an important bearing on the qualities of the final product. One of the effects of the step is a partial scalding or cooking of the vegetables at least at their surfaces whereby their structures are broken down and more or less of the soluble constituents thereof are freed for solution, so that during this process a leafy vegetable such as spinach may lose as much as thirty per cent of its total dry matter and so be deprived of a considerable and important part of its nutrient value. The method of blanching vegetables at temperatures about that of boiling water also makes possible an undesirable abrasion and breaking up of the vegetable during the subsequent process of filling it into cans. With respect to the question of color, blanching at temperatures about that of boiling water, even when followed by an application of cold water, has been shown by experiment to have no measurable effect in preserving a natural color for the canned vegetable product, so that the product is generally of an unattractive and unnatural color. It will thus be clear that the present method of blanching at temperatures about that of boiling water is accompanied by unnecessary and even harmful effects to the vegetable, which effects have tended, particularly in the case of the green and leafy vegetables, to limit the consumer demand therefor.

It will now be noted that as the chlorophyll of green vegetables is heated to a sufficiently high temperature it changes from its normal colloidal form into a solution in the wax of the chlorophyll carrying cells, and that when it is so dissolved the organic acids of the vegetable may react with it to produce the brownish compound phaeophytin and the before-mentioned change of color occurs. During the heating and as a preliminary to such solution of the chlorophyll, the chloroplasts undergo certain changes in their structures, which changes are of a permanent nature, so that even though a heating be discontinued before the before-mentioned solution of the chlorophyll takes place, permanent changes in the physical and chemical qualities of the chlorophyll are effected. It will thus be clear that if a wilting of the vegetable could be effected at such a temperature or under such other conditions as would prevent a solution of the chlorophyll in the wax of the leaf cells, the action of the acids of the vegetable on the chlorophyll during the wilting process may be minimized and it is to the application of this principle that the present invention particularly relates.

As applied generally to the preparation of a vegetable for canning, the steps in my process comprise a preliminary washing of the vegetable in cold water, and thereafter subjecting it for a time to a temperature below that at which the chlorophyll thereof would be rendered appreciably available to the acids of the vegetable, such application of heat being preferably effected by means of hot water. As applied specifically to the
canning of spinach, it has been found that the maximum allowable temperature for the purpose is approximately 160 degrees Fahrenheit, it being obvious that the desirable temperature of the water will vary somewhat as between different vegetables or even for the same vegetable when grown under different conditions. It will, of course, be obvious that with the temperature so far below boiling, the time required for effecting the wilting will be correspondingly longer than that required in the present practice of wilting at temperatures close to the boiling temperature of water. On the other hand, the temperature penetration in the longer time will be more thorough and even, so that a more uniformly treated product results, and the fact that no appreciable cooking of the vegetable occurs eliminates the question of the loss of the valuable soluble constituents.

When a vegetable prepared for canning in the manner of my invention is subsequently canned by a process including its heating to adequately sterilize the canned product, the product is found to have a color very close to the natural color of the vegetable, thus clearly indicating that the wilting performed in the manner of my invention has fixed or set the chlorophyll against the usual color changing effect of the subsequent and necessarily high sterilizing and cooking temperatures. From a consideration of the foregoing discussion relating to the effect of heat on the chlorophyll, it appears that the changes effected in the chloroplasts by the uniform and relatively slow heating thereof at the temperature specified are such as to render the chlorophyll thereafter less susceptible to the influence of heat for transforming it into phaeophytin. That such is indeed the case is further indicated by the fact that, after a period of not less than about four minutes of the treatment at the fixing temperature, the temperature may then be appreciably raised without effecting a change in color of the vegetable, it being noted that such increase in temperature may be utilized to complete the wilt at a faster rate and so hasten the process.

It is to be particularly noted that the process now described for improving the quality and color of canned vegetables has been in use for some time and that the results thereof have been both positive and universally dependable. And it will be further noted that while the application of the process is herein more specifically set forth is that which has been used in the canning of spinach, the same may be effectively applied to the preparation of other chlorophyll containing vegetables for canning.

In another patent, No. 2,020,645, November 12, 1935, issued to B. A. Hook, Oakland, California, covering very nearly the same points, the matter is summed up in the last claim as follows: "In combination with an operating rotary tumbling drum, the process of preparing greens for canning which comprises the steps of effecting a preliminary wilt heating of the greens in the drum at a temperature above 190° F. for not over three minutes, and completing the wilt in the tumbler drum at a temperature below 140° F." The object is the same, to retain the green color in the finished product.

The German chemist, J. Koenig, in 1904 observed that there was a loss of nutriments in parboiling or blanching vegetables, and his observations have been confirmed many times. Other German workers suggested that vegetables be steamed instead of being heated in water to get the blanching effect without loss of valuable substances, and the practice is followed in canning to some extent in that country. Nutrition chemists here have called attention to the losses from parboiling vegetables when prepared for the table, and the inference has been that the same holds for blanching, and that canned foods have their nutritive value reduced. In 1922 the Bureau of Plant Industry published a bulletin upon "Scalding, precooking, and chilling as preliminary canning operations." Two paragraphs from the conclusion are as follows: "When scalding is done in boiling water, there are losses of soluble food materials. These may amount to as much as 16 to 30 per cent of the total dry matter, as in the case of spinach, or as little as 1 1/2 to 10 per cent in the case of string beans. When the scalding is done in
steam, very little of such losses take place, unless the water of condensation is allowed to drip through the material.

"Some form of scalding is desirable in the preparation of most vegetables, especially when they are canned in tin. Live steam, if available, is preferable to boiling water, since it produces all the desirable effects of scalding without causing appreciable loss of nutrient materials."

Steam blanching of spinach was tried as a commercial operation by E. J. Judge in 1905. He recognized that some of the best part of the spinach was being lost and developed a machine to blanch with steam. It was used during three seasons, but canners did not take to it kindly, so it was dropped. One of the inherent difficulties in steam blanching of products of this kind is that unless they are in very thin layers the outer material receives the heat, collapses, and protects that on the inside, resulting in an uneven product. This has been observed more particularly in blanching as a preparatory step in dehydrating. A few firms are now blanching in steam for three minutes, bringing the product to 165°, and depending upon a long exhaust to get a good vacuum. The product is better but there is difficulty in getting the required weight and cut-out. Another modification in blanching is to use the rotary blancher but spray the spinach with hot water as it produces a more uniform result.

The effect of blanching is to cause some loss of weight, and this will vary with the length of time and the temperature, as may be shown by weighing lots which must drain uniformly in passing from the blancher to the filling table.

The total loss in any factory depends upon the method and time allowed for draining, but with these constant the influence of any other factor can be determined. The five experiments already cited under washing were continued through the blancher. Two lots were water blanched, and three were steam blanched. The water blanching was for two minutes with the entrance temperature in the bath at 205° F., and exit 212° F. The same blancher was then drained and steam turned in, producing a temperature between 212° and 214° F. The loss in both methods was the same, 3.05 per cent. The loss of weight in blanching in the regular factory run on the same date was 3.50 per cent, the slight difference being accounted for by the promptness in handling the experimental lots. The loss in weight from blanching through the season is believed to be more nearly 7 per cent, but an insufficient number of determinations were made to draw a positive conclusion. A check on the overflow water from the blancher also shows that the loss of soluble solids is small. The overflow is determined by the amount of water carried into the blancher from the washer, the condensation of steam, and the amount of water added to keep the bath clean. After the machine has been operating for a half-hour or more, the amount of solids in the overflow will give a good indication of what is taking place. Determination of losses by weighing on the canning table can be accepted as only approximate, as no one can tell how much of the weight is due to adherent blanch water nor just what escapes in the cooker and in draining. The loss of weight at the trimming table plus the loss on blanching will give the total loss for the product, which varies from 40 to 55 per cent.

The belt type of spinach blancher has been more nearly standardized than any other part of the equipment. It consists of a tank with two woven
wire belts, the lower to carry the spinach through the bath and the upper to force the spinach beneath the surface of the hot water. It handles the material gently but very effectively. The tank is generally about 30 feet long and 3 feet wide inside, rated to have a capacity of from 3 to 6 tons per hour.

Filling the Cans

The blanched spinach is conveyed from the blancher to the can-filling tables on either woven wire or rubber belts, and in this operation a certain amount of drainage takes place. This may be further augmented by passing the spinach under a light roller or wringer to press out any free water caught between the leaves. The spinach is discharged on close wire screens set in the regular table basins, into water basins, or into pans. It can be appreciated that a varying amount of fluid will be lost, depending upon the belt drainage and the amount of drainage which is permitted in the receptacle. The cans are filled with hot spinach, which is pressed down gently and the excess water turned out, then weighed and adjusted to the proper fill upon the basis of the weight. The cut-out weight is fixed by a regulation under the Food and Drugs Act and each packer must determine from his own conditions the amount to weigh in to produce the proper fill. The amount of blanch and the amount of drainage are the two important factors in determining this point, and where both are well done the filling weight will be close to that of the cut-out. Spinach filled from dishpans and undrained table sinks give the most troublesome uneven fill, as the spinach at the bottom or that carried over after receiving additions from the blancher becomes water-logged. Filling directly from the conveyor belt is gaining favor in the newer installations. This requires an even feeding of the blancher in order to keep the labor on filling well balanced.

Most of the filling is done by hand, by women who wear gloves to afford protection against burns, but as their hands become tender, a change of operatives has to be made at short intervals. Some of the trouble in this instance can be mitigated by the use of tongs or forks, but real relief will come through the use of filling machines. One machine has passed the experimental stage and fills rapidly and accurately, but cuts a few leaves in regulating the fill, a trifling defect compared with some others which cannot be so readily seen. The damage amounts to little more than is inflicted by the peg used in forcing an opening in the center of the mass to admit the brine. Machine filling is the logical procedure to get the material into the cans promptly without cooling and with a uniformity of fill. The importance of these two factors is not generally appreciated but the addition of a half-ounce or more above the standard weight for a No. 2½ can is reflected as promptly and as strongly by the thermometer at the center of the can as by the scale. The farther the deviation from the normal weight, the more pronounced is the effect upon the subsequent heat penetration.

Formerly spinach was allowed to cool or was sprinkled with cold water to enable the packers to handle it and to avoid matting and undue softening of the leaves, which is in line with the practice followed with other vegetables. Obviously this was bad practice as far as heat was concerned, and necessitated reheating the material in the exhaust box or cooker. After filling in the solids, which occupy from two-thirds to three-fourths of the space, the brine is or should be added without delay so as to get through the mass before it settles tightly together. The penetration of the brine
through the mass is hastened by pushing a wooden peg through the center to the bottom, especially in No. 10 cans. A requirement in California is that instead of the usual peg, a pointed nozzle be used and the brine be injected into the mass, the brine being maintained at as near 200° as practical. The brine is usually made with 2 to 3 per cent salt, 2 per cent being a little weak for spinach.

Exhausting

The primary object in exhausting spinach is to get a uniform temperature in the cans prior to their entrance into the cooker, since the blanching drives out the air and gases, except the small amount entrapped in filling. The usual effort is to get the temperature in the spinach as near 180° as is practical and therefore the operation will depend upon the condition of the spinach as it arrives from the filler. If the work be done rapidly with little loss of heat, then the exhaust may be short, but if the spinach be allowed to cool, a long exhaust is desirable as the heat penetration is slow. A high degree of heat in the exhaust box causes the spinach to rise above the top of the can, which interferes with sealing, whereas a lower temperature in the box continued for a longer time will effect the proper heating without causing the spinach to float. A temperature above 180° in the can causes the brine to overflow, excessive and irregular head space, and collapse of cans, especially the No. 10 size. Some packers prefer not to exhaust so high but to seal at a temperature at about 150° and pass the cans through an agitating cooker to bring the contents above 180° before going into the retort. This has a very distinct advantage as the spinach is broken apart and evenly distributed in the brine and helps greatly in the subsequent cooking.

The time generally used for exhausting No. 2 and No. 2½ cans is from 5 to 7 minutes, and for No. 10 cans from 10 to 14 minutes.

Cooking

Spinach is not inherently more difficult to sterilize than other vegetables. It is contaminated by the same soil organisms, though the amount of contamination may be greater. The real difference is with the heat penetration in the can and the lack of appreciation as to the effect small differences in the amount of solids have upon this factor. The leaves mat and arrest convection currents, a condition which is aggravated by close filling.

The sterilization of spinach has been one of progressively higher and higher temperatures. In 1895, the best practice favored the use of 212° for one hour to an hour and a half for No. 3 cans; in 1900, 235° for 25 to 30 minutes; 1905, 240° for 20 minutes; 1906, 240° for 25 minutes; 1911, 240° for 30 minutes; 1913, 240° for 30 minutes; 1918, 240° for 30 minutes. These figures are for Eastern factories, but there are no data available as to the drained net weights though it is the belief that they were lower than at present. Neither are there data upon the losses which may have occurred. In 1912, E. W. Duckwall advocated the use of 240° for 60 minutes for No. 10 cans and the following year recommended the same process for No. 3 cans. This was based upon numerous laboratory tests and his knowledge of factory losses. In 1913, spinach was packed by the writer in the U. S. Experimental Canning Laboratory in San Francisco, cooking
at 235° for 35 and 40 minutes respectively, and without spoilage when the cut-out weight was less than 20 ounces of solids in the No. 2½ can.

The cooking of spinach in California is regulated by the State Board of Health, and differs so radically from the foregoing that the regulation is quoted. The first regulation of 1922 is as follows: "Canned spinach shall be deemed adulterated within the meaning of the California Pure Food Act unless the same shall have been thoroughly and repeatedly washed in fresh water, blanched according to the best technical procedure, placed in retorts with an inside temperature of not less than 180° F., and sterilized at a temperature of not less than 252° F. for 50 minutes if packed in No. 2 or No. 2½ tins, or if packed in No. 10 tins it shall have been sterilized at a temperature of 252° F. for 90 minutes." This regulation was modified in 1924 as follows: "That inasmuch as the Federal Government has reduced the minimum cut-out weights on spinach to 66 ounces for No. 10s, 19 ounces for No. 2½s, and 13 ounces for No. 2s, and that inasmuch as these minimums insure more rapid heat penetration, . . .

"A No. 10 can shall receive not more than 84 ounces of blanched spinach, including weight of can, and shall be sterilized for 60 minutes at 252° F. The time (60 minutes) shall be counted after the retort has reached the temperature of 252° F. The pack should reach the retort with an initial temperature of not less than 140° to 150° F.

"A No. 2½ can shall receive not more than 24 ounces of blanched spinach, including weight of can, and be sterilized for 45 minutes at 252° F., observing the conditions mentioned for No. 10s.

"A No. 2 can shall receive not more than 17 ounces of blanched spinach, including weight of can, and be sterilized for 40 minutes at 252° F., observing the conditions mentioned for No. 10s.

"The methods of blanching and the lengths of time in the blanch will influence the cut-out weights, but a leeway to 68 ounces for No. 10s, 21 ounces for No. 2½s, and 14½ ounces for No. 2s is herewith permitted. Special care shall be exercised to avoid overfilling, and the personnel shall be instructed accordingly."

The cooking schedule at present is as follows:

<table>
<thead>
<tr>
<th>Can</th>
<th>Initial Temperature</th>
<th>Report Temperature</th>
<th>Time</th>
<th>Maximum Drained Weight (ounces)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 oz. (Tamale)</td>
<td>140</td>
<td>252</td>
<td>35</td>
<td>6.0</td>
</tr>
<tr>
<td>8 oz. (Buffet)</td>
<td>140</td>
<td>252</td>
<td>35</td>
<td>6.25</td>
</tr>
<tr>
<td>No. 1</td>
<td>140</td>
<td>252</td>
<td>35</td>
<td>8.0</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>140</td>
<td>252</td>
<td>35</td>
<td>11.5</td>
</tr>
<tr>
<td>No. 2</td>
<td>140</td>
<td>252</td>
<td>45</td>
<td>14.5</td>
</tr>
<tr>
<td>No. 2½</td>
<td>140</td>
<td>252</td>
<td>45</td>
<td>21.0</td>
</tr>
<tr>
<td>No. 3</td>
<td>140</td>
<td>252</td>
<td>45</td>
<td>24.0</td>
</tr>
<tr>
<td>No. 10</td>
<td>140</td>
<td>252</td>
<td>50</td>
<td>70.0</td>
</tr>
</tbody>
</table>

These temperatures apply equally to both still and agitating.

A supplementary regulation permits cooking in the continuous agitating cooker as follows: No. 2 cans, 26 minutes; No. 2½ cans, 29 minutes; and No. 10 cans, 36 minutes at 252° F.

The present cooking schedules are a decided improvement upon those demanded in 1922. They are severe, causing some discoloration and softening of the product, as well as injury to the flavor. They were promulgated
as a result of unfortunate cases of food poisoning following the packs of 1919 and 1920. As far as can be learned, the same schedules are neither necessary nor desirable in other places.

It may be added that turning the can on the side in the retort is advantageous. In filling the can the mass is layered which tends to prevent the circulation of the hot brine in the can. Turning on the side tends to permit the brine to circulate between the layers, the reverse of what happens in asparagus or asparagus packed beans.

The French cook in 1890 was 237° F. for 22 minutes, and continued the same through 1925, that being the last record available. This is for liter cans (practically the same as the No. 2½).

The German cook in 1913 was 242° F. for 35 minutes, and the same in 1920. In 1925 a recommendation was made that 250° F. be used for 30 minutes. This latter change is due to the use of spinach from sewer fertilized lands. The German style of packing is much like our own, but the filling is a little closer.

After cooking, the cans should be cooled promptly and code marked.

The drained cut-out weight was first made the subject of a Federal Regulation in 1918, but too late to govern the pack of that season, was revised in 1919, and again revised in 1923. The weights of solids, expressed in ounces, after draining, are as follows:

<table>
<thead>
<tr>
<th>Can Number</th>
<th>1918</th>
<th>1919</th>
<th>1923</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>16</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>2½</td>
<td>24</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>25.5</td>
<td>21.5</td>
</tr>
<tr>
<td>10</td>
<td>85</td>
<td>78</td>
<td>66</td>
</tr>
</tbody>
</table>

The last revision is in force and gives a reasonably well-filled can, and at the same time permits heat penetration without injuring the product.

The packing at present is about 30 per cent in No. 2 cans; 40 per cent in No. 2½ cans, and 30 per cent in No. 10 cans. Plain tin is used.

**Label Weights**

(Sp. Gr. .98). 8Z Short, 8 ozs.; 8Z Tall, 8¾ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.

**TENTATIVE UNITED STATES STANDARDS FOR GRADES OF CANNED SPINACH**

February 10, 1933

NOTE: These grades have been so drafted that they may also be used in grading other greens such as canned turnip and mustard greens. In grading these products for color, however, the typical characteristic color of the greens shall be considered.

**Definition**

Canned Spinach is the canned vegetable prepared from succulent leaves of fresh spinach (*Spinacea Oleracea*) by proper sorting, trimming, washing, blanching, with or without the addition of salt, with the addition of the necessary amount of potable water, packed in hermetically sealed containers, and sterilized by heat.

**Grades of Canned Spinach**

U. S. Grade A (Fancy) canned spinach is the product prepared from young, very tender succulent leaves of the spinach plant; is practically free from grit, tough or stringy leaves, and other defects. The product is dark green in color; possesses the
typical flavor of fresh spinach; and scores not less than 85 points when scored according to the scoring system outlined herein.

U. S. Grade C (Standard) canned spinach is the product prepared from young, tender leaves of the spinach plant; is reasonably free from grit, tough or stringy leaves, and other defects. The product is dark green in color; possesses a desirable flavor, and scores not less than 70 points and need not score more than 84 points when scored according to the scoring system outlined herein.

Off-Grade (Substandard) canned spinach is canned spinach that scores below 70 points when scored according to the scoring system outlined herein, or, when any one of the grading factors falls in the subdivision D.

Prerequisites to Grading

Fill of Container—Cans of spinach will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container; and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned spinach that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"

"Slack Fill"

A certificate of grade covering canned spinach that does not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend,

"Below U. S. Standard—Slack Fill"

"Contains Excess Added Liquid"

Net Drained Weights—The minimum net drained weight of spinach, after draining two minutes over a circular sieve of proper diameter and containing 8 meshes to the inch (.097 inch perforations), shall be not less than 66 per cent of the net contents of the can.

The maximum head space allowable in the sizes commonly used in packing spinach is shown in the accompanying table:

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum Capacity in water at 68° F. (in ounces)</th>
<th>Maximum Head Space Allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 2½</td>
<td>29.79</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 3</td>
<td>35.08</td>
<td>10.2</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Ascertaining the Grade

The grades of canned spinach may be ascertained by considering the following factors: Color, absence of defects, tenderness and texture, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color ........................................ 20</td>
</tr>
<tr>
<td>II. Absence of Defects .......................... 25</td>
</tr>
<tr>
<td>III. Tenderness and Texture ..................... 40</td>
</tr>
<tr>
<td>IV. Flavor .................................... 15</td>
</tr>
<tr>
<td>Total ........................................ 100</td>
</tr>
</tbody>
</table>

Ascertaining the Rating of Each Factor—The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means, 12, 13, and 14.

I. Color.

(A) Spinach that possesses a uniformly good color typical for the variety, may receive a credit of 17 to 20 points for this factor.
(C) If the color is variable, containing leaves of poor color, or shows noticeable browning or yellowing, a credit of 14 to 16 points may be allowed.

(D) If the color of the product is decidedly "off"—that is, decidedly pale or brown—a credit within the range of 0 to 13 points may be allowed.

II. ABSENCE OF DEFECTS—The factor of absence of defects refers to the freedom from defects such as grit, wilted leaves, discolored leaves, leaves showing insect injury, seed stalks, crowns or root stubs, or grass blades.

(A) To receive a rating within the highest group, 21 to 25 points, for this factor, the product must be practically free from the defects mentioned.

(C) If the product is reasonably free from such defects, but are not prominent, the product may receive a credit of 17 to 20 points. Spinach that falls in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) If defects similar to those mentioned are prominent, a credit within the range of 0 to 16 points may be allowed.

III. TENDERNESS AND TEXTURE—The factor of tenderness and texture has reference to the structure and character of the spinach leaves, and takes into consideration the degree of coarseness or stringiness of the stems and vascular system, and the physical condition of the leaves—that is, their tendency to remain whole or to break apart or become shredded, or to disintegrate with the result that the characteristic form of the leaves is lost.

(A) To receive a rating within the highest group, 34 to 40 points, for this factor, the leaves and stems must be very tender and succulent, and practically intact.

(C) If the product shows a somewhat shredded condition of the leaves, or a tendency to disintegrate, or the leaf stems somewhat fibrous but not tough, a credit of 28 to 33 points may be allowed. Spinach that falls in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) Spinach that shows an objectionable shredding of the leaves, or that possesses a soft, slimy or "mushy" consistency, or in which tough fibre is prominent, shall be given a credit within the range of 0 to 27 points.

IV. FLAVOR—The quality of flavor of canned spinach shall be classified from the standpoint of palatability. The natural flavor of the spinach is to be considered, regardless of the addition of condiments.

(A) To receive a rating within the highest group, 13 to 15 points, for this factor, the product must possess the typical flavor of fresh spinach.

(C) Spinach that possesses a desirable flavor but lacks somewhat the characteristics of group (A) may be given a credit of 11 to 12 points. Spinach that falls in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.

(D) If the flavor or aroma is distinctly disagreeable or objectionable the product shall be given a credit within the range of 0 to 10 points.

Spinach as a Food

A search of some of the more important works upon cookery discloses many interesting things concerning this pot-herb and the estimation in which it has been held at different times. The first is that the plant has been used for a longer time and over a greater part of Europe than has been accredited by botanists and horticulturists. Second, that the plant was first used for its physiological or medicinal effects and that these were well known. Third, that relatively little change has taken place in the mode of preparing this dish in recent years.

S. R. A. 320. Weights of Spinach, Swiss Chard and Beet Tops in Cans of Various Sizes.

An investigation recently concluded by the Bureau indicates that properly filled cans should yield at least the following drained weights of spinach, the weight being determined in each instance by draining for 2 minutes on an ½-inch mesh screen:
No. 2: 3 3/4 by 4 3/8 inch sanitary, and 3 3/4 by 4 3/8 inch hole and cap....................15 ounces
No. 2 1/2: 4 1/2 by 4 1/2 inch sanitary, and 4 by 4 1/2 inch hole and cap (22 ozs.).................................1 pound 6 ounces
No. 3: 4 1/4 by 4 3/8 inch sanitary, and 4 1/4 by 4 3/8 inch hole and cap (25.5 ozs.).................................1 pound 9.5 ounces
No. 10: 6 3/8 by 7 inch sanitary, and 6 3/8 by 6 3/4 inch hole and cap (78 ounces).........................................4 pounds 14 ounces

The weights just mentioned apply also to Swiss chard and beet tops packed in cans of the sizes given. A can of size not mentioned here should yield a drained weight which bears the same relation to the drained weight indicated for the can nearest in size as that existing between the capacities of the cans in question.

In the case of spinach it has been found that the put-in weights required to give the cut-out weights mentioned in the preceding lists will vary somewhat with the character of the spinach. For instance, a given put-in weight of fall-packed spinach usually yields a higher cut-out weight than the same put-in weight of spring-packed spinach.

Furthermore, the cut-out weight yielded by a certain put-in weight of spinach, Swiss chard, or beet tops will vary markedly in any given factory in case the manner of draining after blanching is not uniform, this being due to the fact that the spinach, Swiss chard, or beet tops put in the cans under such condition contain varying amounts of liquid. Each packer should, therefore, make certain that his method of draining after blanching is uniform, so that this cause for variation in cut-out weight may be eliminated.

All cans should be packed with the maximum amount of spinach, Swiss chard, and beet tops which is consistent with maintenance of quality, and the cut-out weights mentioned in the preceding list should be exceeded whenever this is possible.

In making declarations under the net weight requirements of the Federal Food and Drugs Act the total weight of the contents of the can, liquid included, should be declared.

S. R. A. 380. Weights of Spinach in Cans of Various Sizes.

The cut-out weights for canned spinach announced in item 320, page 118, Service and Regulatory Announcements, Chemistry 24, and amended by item 365, page 31, Service and Regulatory Announcements, Chemistry 27, are further amended as follows:

No. 2: 3 3/4 by 4 3/8 inch sanitary, and 3 3/4 by 4 3/8 inch hole and cap....................13 ounces
No. 2 1/2: 4 1/2 by 4 1/2 inch sanitary, and 4 by 4 1/2 inch hole and cap. (19 ozs.).................................1 pound 3 ounces
No. 3: 4 1/4 by 4 3/8 inch sanitary, and 4 1/4 by 4 3/8 inch hole and cap. (21.5 ozs.).................................1 pound 5.5 ounces
No. 10: 6 3/8 by 7 inch sanitary, and 6 3/8 by 6 3/4 inch hole and cap. (66 ounces).........................................4 pounds 2 ounces

In other respects item 320 remains unchanged.


It has come to the attention of the Bureau that certain canners of Swiss chard are labeling this product as canned spinach. The Bureau is informed that spinach and Swiss chard are two entirely distinct varieties of vegetable, and that their names are, accordingly, not interchangeable. The labeling of canned Swiss chard as spinach or as a variety or type of spinach is regarded as a violation of the Federal Food and Drugs Act.
Sweet Potato

Ipomoea batatis

The sweet potato holds nearly the same relative position in the culinary art in warm countries as the white potato does in temperate climates. It is accredited as being a native plant unknown to Europe and not mentioned in the older eastern languages, such as the Sanscrit or its more modern successors prior to the time of Columbus. The circumstance which has raised some doubt as to its nativity is the fact that it has been cultivated simultaneously in some of the islands of the Pacific and in parts of Asia, points thousands of miles apart and with no known means of communication, but in no place has it been found growing spontaneously away from human habitation or from lines of travel. China claims to have known the plant since 200 or 300 A.D. The fact that all the known species, fifteen in all, occur in the New World lends strength to an American ancestry and that its diffusion began with migrations which antedate historical records.

The sweet potato was carried to Spain by Columbus on his first voyage and offered to Queen Isabella as Camote, amote, or ajes, the latter being the Caribbean name for yam. Peter Martyr, in 1514, gave it the name batate, which is of American origin and that was adopted by the early navigators and is so given in the account of Magellan's voyage. It may be added that batate is the mother word from which potato was derived and that the latter was synonymous with pomme de terre. The English further modified the term to potato and also applied the same designation to the white tuber of Solanum tuberosum which is in no way related to it. The cultivation of the plant began in Spain, Portugal, and Italy about the middle of the 16th century and has been an important item in those countries ever since. It did not meet with much favor in the more northerly countries and therefore made little progress in cultivation there except as an oddity. About 1800, it had a vogue with the French court under Napoleon but this did not last long.

The plant is a low-growing trailing vine with dark green leaves which are triangular or heart shaped, and in this country seldom flowers above the frost line. The cultivated varieties present many variations, from very short vines scarcely a foot in length to those growing 15 feet or more; from leaves being nearly entire to deeply cut; from roots which are long and cylindrical in shape, 8 inches to a foot or more in length, to short, thick and tapered at each end; from slender to three inches in diameter and also to a nearly globular form. The variations in color and texture are equally pronounced, from a nearly white through a light, deep or reddish yellow; from a fairly firm consistence which holds its shape after moderate cooking to one which softens and becomes decidedly moist.

The plant retains its tropical nature and is easily killed by a light frost. It can be propagated above the frost line by planting the roots only, in most cases this necessitating the use of artificial heat when starting until they are well sprouted, after which the sprouts are cut apart and set in the fields. Under these conditions it is strictly an annual.

For culinary purposes, the varieties may be placed in three groups: The first group embraces those which are fairly dry and mealy. These are generally long and slender, the flesh firm and with a pronounced yellow color.
The Big Stem Jersey is typical of the group and the one most extensively grown. The largest producing sections for this class are New Jersey, Delaware, Maryland, Virginia, and California. This type is preferred in the northern markets both fresh and canned. The second group comprise medium sized potatoes which taper at both ends, with much thicker skin, and flesh of a lighter color that breaks down more easily in cooking than in the previous group. A good representative of the latter group is the Southern Queen, grown extensively in the South, and the one most used for canning. The third group is made up of the yams which vary in size and are generally pointed at both ends. They are of a deep yellow or reddish color, and the reddish cast becomes intensified upon heating. They break down easily and become decidedly moist and sirupy which detracts from their appearance when canned. That, however, is only a matter of taste for many persons, especially in the South, prefer this type both fresh and canned and the sirupy appearance is taken as a mark of superiority. Typical representatives of this group are Nancy Hall, Pumpkin Yam, and Porto Rico.

The characteristics and canning qualities of the principal varieties of the sweet potato have been studied and set forth in detail in a bulletin from the Department of Agriculture.*

The quantity canned is not large, 368,000 cases in 1929, though average production is more nearly 300,000.

Cultivation

The sweet potato is generally grown on a light loam or sandy soil and usually in ridges formed by throwing two furrows together about 3½ feet apart with the plants set 18 inches apart in the row. They require clean cultivation until the vines cover the ground, and while the plant succeeds fairly well on a thin soil, the yield is proportional to the fertility. The harvesting is done when the potatoes are mature or immediately after a frost, generally in October or November. In the event the vines are killed by frost, they are cut free from the roots to prevent softening of the tips and the potato may be left in the ground several days or even weeks. If the canning is to be done at once, the digging can be done at any time, but if the potatoes are to be stored, it is desirable that the ground be dry and the potatoes remain in the air until thoroughly dry before being collected. The yield per acre varies considerably in the different sections and with the varieties but the average is about 125 bushels.

While it is generally desirable to dig the crop and deliver directly to the cannery in order to save labor, this is not possible at all times because of weather conditions or because the factory lacks capacity to handle the crop quickly. Magoon and Culpepper found in the bulletin already cited that changes occurred in all varieties during the curing and storing with fairly wide variations, but that by proper selection canners could use potatoes from storage which would give good results and thus prolong the operating season. They found that during curing and storage that some of the starch changed into sugar and intermediate products which are of a less firm character.

Grading

The first factory operation is that of grading for size, those more than 2 inches in diameter are classed as large, those less than 2 inches but more than 1 ¼ inches as medium, and those below 1 ¼ inches as small. Culls are made up of irregular, misshapen, cut, broken, and small potatoes either unsuitable or requiring too much labor for their preparation. If the crop be heavy, most of the small potatoes are classed as culls.

The grading is done most easily on a spreading rope grader as the irregularities in shape interfere less than with most other types. This step is desirable where the peeling is done by steam but is of assistance in any method.

The graded potatoes are soaked to loosen the adherent soil and then washed under strong sprays.

Peeling

Most peeling is done by a combination of steaming in a retort and separating the skin by hand as that is adapted to all varieties and conditions and furthermore the equipment is easily obtained. The potatoes are placed in boxes or in retort crates in layers, preferably not more than six inches deep. If the crates be used, it is better that they be wood lined to prevent the potatoes coming in direct contact with the iron as a certain amount of discoloration is sure to result if this precaution be overlooked. The steam is turned into the retort rather slowly, that is, taking from 5 to 7 minutes to bring the temperature up to 240°, and is held there from 6 to 10 minutes for the small size, from 10 to 18 minutes for the medium size, and up to 25 minutes for the largest potatoes. Gradual heating is desirable to avoid bursting the skins and the holding time made somewhat longer than is necessary for loosening the skins in order that the potato may be heated to the center. This accomplishes three things; it makes the potato more pliable for handling, protects the color, and serves the same purpose as exhausting in that it gets rid of the air and gases in the tissues. The raw potato discolors quickly in the air and heating is the best preventive for this. When the heating period is up, the retort is opened promptly to favor rapid evaporation of steam to aid in getting a dry product in the can. The steaming can be done at a lower temperature, as 220° to 230°, the color will be somewhat brighter, and there is less tendency for the formation of a sirupy condition, but the time has to be increased. If the potatoes be medium size, fresh and in good condition, the lower temperature will give a strictly fancy product.

The potatoes are delivered to the peeling tables as quickly as they can be handled and may even be kept covered with canvas to retain their heat. The peel is removed by squeezing it off and women wear heavy cotton gloves to do the work in order to prevent discomfort or burns. The potatoes are filled directly into the cans, whole or in pieces, crowded as closely as possible. They are filled by weight, 1 pound 12 ounces for a No. 2½ can, or 1 pound 15 ounces for a No. 3 can, and given a final pressing by means of a disk which fits the top of the can and leaves only enough headspace to apply the cover.

As very little time is expended in arranging the product in the can, some mashing is almost certain to occur. Some packers add from one-half to
one ounce of brine per can in order to have steam to conduct the heat, which
in addition contributes to a brighter color though it gives a moist and some-
what soggy effect. Other packers omit this step and have excellent results
if the work be done speedily.

If the potatoes be at 150° or above, preferably at 160°, overfilling cannot
occur, no exhaust will be needed, and the color be all that can be desired
if the sealing be done at once. If the potatoes be allowed to cool, then a
short hot exhaust is needed to get rid of any air that may have become
imprisoned when packing. The air and gases in the tissues having been
removed in the first heating, a short exhaust suffices. The difficulty in
thoroughly exhausting cool potatoes may be demonstrated easily by plac-
ing two thermometers in a can, one near the side and the other at the center.
When the former reaches 135° to 145° the latter may be only 90°.

Pie Style

Another style of packing is known as pie style which is not much used
for firm potatoes but is common with the moist white varieties. The pre-
liminary preparation by steaming is the same but in this case it is preferable
to hold the temperature between 220° and 224° and prolong the time
rather than to raise it to 240°. At the latter temperature the potatoes are
prone to become sticky and to take on an overcooked appearance. The
peeled potatoes are run through an Enterprise style of crusher and packed
into the can as quickly as possible, then well pressed to make a practically
solid mass. The saving in the smaller potatoes is noticeably increased by
using the lower temperature as the skin slips off with less waste of the
tissues underneath.

Lye Peeling

Lye peeling is used to a certain extent for the Jersey type of potatoes
and particularly for the smaller and irregular sizes as the work can be done
quickly and with much less waste than by steam peeling. A lye peeling
equipment, such as used for handling peaches, is best to get continuous
action, but since that is not found in most sections where potatoes are
canned, a single batch equipment can be improvised for work on a small
scale. The requirements are a hot water kettle or tank for preheating the
potatoes, another for holding the hot lye, and a tank with running water
for washing. Simple tanks heated by a steam pipe or closed coil or a large
tank will answer. The potatoes are handled in wire baskets holding a
bushel.

The potatoes for lye peeling should be freshly dug and not exposed to
the air for more than a few days as otherwise the epidermal layers become
corky which makes removal difficult and irregular. The points from which
the rootlets emerge become dark and even black and persist after peeling
so have to be removed by hand as they are unsightly. If the skin becomes
dried, the method is not practical.

Preheating of the washed potatoes is necessary for both economical and
uniform operation. By heating the surface, a weaker solution and a lesser
amount of lye can be used, the time of treatment shortened, and the waste
decreased. The time in the water bath needs to be from 1 ½ to 2 minutes
though a longer time will do no harm, and in the lye solution from less than
1 minute to 5 minutes depending upon the condition of the potatoes and
the strength of the lye. A 3 per cent solution is about standard and can be
increased or decreased as may be found necessary upon trial. An excessively strong solution soon becomes gelatinous and interferes with good work. When such a condition develops, it is better to empty the tank and start fresh rather than to try to correct it. The keeping of the potatoes in the lye from 3 to 5 minutes is no disadvantage other than limiting the capacity of the apparatus. If, however, the potatoes do not peel within five minutes, the process is not suitable for the purpose:

The cauterized peel is easily washed off, a squirrel-cage washer with a spray on the inside being used generally by the small packers though this is probably in violation of a patent. However, running water and a brush will suffice and the work can be done quickly.

According to one factory record, it requires about one pound of caustic soda per bag (100 pounds) of potatoes but this is doubtless above the average due to working at too low a temperature or the potatoes being dry. It is advisable to make up a strong solution to be added to the tank by a measure made to correspond to a definite number of bushels and the addition made at short intervals. It will not do to allow the strength to be decreased materially and then built up in excess. The water level in the tank must also be maintained.

Potatoes peeled in this manner may be steamed until heated through and filled into cans as already described, or they may be filled directly into cans, cutting the long ones to about one-fourth inch less in length than the height of the can. They are then given a hot exhaust from 18 to 20 minutes to accomplish the same purpose as steaming.

The waste in peeling by the two methods and for different varieties of potatoes has not been determined. From a record of the number of tons of potatoes delivered to a factory and the number of cans obtained where steam peeling was followed, it was estimated that the waste amounted to about 40 per cent. The refuse may be dried and makes a good hog feed. No such use can be made of the waste from those lye peeled.

Peeling by means of abrasion machines or by knives is impractical.

**Cook**

The sweet potato was formerly cooked in an open bath for three hours or more for No. 3 cans. This gave a bright attractive product which was not sterile but if the preliminary steps had been carried out quickly, there was little trouble for a period of six months or more, and by that time it was hoped that the pack would be consumed. A temperature of only 212° is unsafe and cannot be recommended. A high temperature such as 250° or more is also objectionable in that it produces discoloration and an odor and taste of being over-cooked. The schedule recommended by the National Canners Association in July, 1929, is as follows:

<table>
<thead>
<tr>
<th>Initial Temperature</th>
<th>Cooking Temperature 240° F.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. 1</td>
</tr>
<tr>
<td>Whole</td>
<td>120</td>
</tr>
<tr>
<td>180</td>
<td>80</td>
</tr>
<tr>
<td>Solid</td>
<td>120</td>
</tr>
<tr>
<td>150</td>
<td>65</td>
</tr>
<tr>
<td>180</td>
<td>60</td>
</tr>
</tbody>
</table>

An inquiry among sweet potato packers in 1922 showed that a process of 60 to 65 minutes at 236° was usual and that spoilage did not occur when the sealing of the can was at 150°.
Duckwall advocated cooking sweet potatoes in two periods in order to conserve the appearance. He advised for No. 2½ and No. 3 cans that the first cooking period be made 2 hours at 220° and the second period 10 days later at boiling for a like period. Such a method is too costly for practical purposes.

In order to bring the initial temperature to the proper degree, it is often desirable to run the cans through an open agitating cooker before placing them in the retort. The rotation has the effect of opening some lines for the conduction of steam within the product.

Candied Yam

A special style of packing is known as Candied Yam and more recently a modification designated as Creole style Candied Yam. The former was developed by King Pharr, of Catherine, Alabama, in 1919, and the latter by G. W. Dunbar Co., New Orleans, Louisiana, in 1928. Yams are used for this purpose. The preliminary steps through the steam peeling is the same as for regular packing but at that point the potatoes are placed in pans without touching each other and are given a short bake in a hot oven to bring out the sirup and cause some caramelization. They are then packed in the cans and the operation of sterilization completed. The Creole style potatoes are also packed in glass.

Label Weights

Dry pack: No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 6 ozs.

Vacuum pack: No. 3 Squat, 1 lb. 2 ozs.

Troubles

Sweet potato canning troubles are chiefly of two kinds; first, discoloration at points where there is space between pieces and in the headspace due to a process of oxidation which can be prevented by thorough heating; second, lack of sterility causing souring due to the growth of acid forming bacteria. When the spoilage occurs in contact with the can, there is almost certain to be a bluish or almost black discoloration. Spoilage of this character goes on slowly and if no free moisture be present, it is localized in one or more spots. It is seldom accompanied by gas formation and, therefore, not recognized except by the odor or taste. The sweet potato has a marked action upon tin causing the inside to become gray. Springers which were formerly common have been eliminated by weighing the filled cans to prevent over-filling and by proper exhausting.

Food Value

The nutritive value of the sweet potato is particularly high. The composition of the fresh and canned product as given by Atwater and Bryant, quoted by Magoon and Culpepper, and of the white potato by Frazer as quoted by Wiley are as follows. The composition of the white potato is given for comparative purposes.

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrate</th>
<th>Fiber</th>
<th>Ash</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet potato, fresh</td>
<td>69.0</td>
<td>1.8</td>
<td>0.7</td>
<td>27.4</td>
<td>1.3</td>
<td>1.1</td>
<td>570</td>
</tr>
<tr>
<td>Sweet potato, canned</td>
<td>55.2</td>
<td>1.9</td>
<td>0.4</td>
<td>41.4</td>
<td>.8</td>
<td>1.1</td>
<td>820</td>
</tr>
<tr>
<td>White potato</td>
<td>75.0</td>
<td>0.8</td>
<td>0.33</td>
<td>20.6</td>
<td>1.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The sweet potato shows a low water content and is high in carbohydrates or starches and sugars thus giving a high heating value. In canning a considerable amount of moisture is driven off thus making the analysis appear even more favorable.

Gore, while working in the Bureau of Chemistry, developed a method of producing a table sirup from the culls but no commercial use has been made of it.

**TOMATO**

*Lycoptersicum esculentum*

The tomato is one of the valuable native fruits though often thought of as of European origin as it was introduced into our gardens by that route. The plant was found growing wild by the early explorers in the Antilles, Mexico, and Peru. The first accounts state that it was cultivated by the Aztecs inhabiting Mexico and was one of their best productions. There are a half dozen or more wild species but the one called *Lycoptersicum cerasiforme*, small, cherry-like, sometimes called the Cherry Tomato, is supposed to be the one from which our cultivated form, *Lycoptersicum esculentum*, has been developed, as no other species has been discovered to which there is a closer resemblance.

It was one of the first fruits carried to Spain and suffered through the selection of an inappropriate name due to a resemblance to a European fruit that is poisonous. *Lycos* means wolf, and *persicum* refers to the peach, *wolf of the peach*, applied to the Mandragore. The Spaniards soon learned to use this new fruit and it was obtained from them by the Moors of northern Africa, who, in turn, a little later, supplied it to the Italians. These peoples found it especially suitable for sauces and adopted it into their culinary art, and it so remained for a long time before it was taken up by others. The tomato found its way into France and northern Europe by way of Italy, but in its introduction was treated as an ornamental plant and the tradition associated with the name clung to it, persisting even in this country until the latter part of the last century.

According to Georges Gibault,* “The plant was brought to Europe early, even before the potato, the Jerusalem artichoke, corn, or tobacco. It came from Peru, according to the name adopted by the first botanist; *Mala peruvians*, apple of Peru; in Spanish, *Pomí de Peru*.

“*Pomme d'amour* is also a name contemporaneous with the introduction of this exotic plant, the tomato having been considered originally as a sort of eggplant that bore that name. *Love apple, liebesapfel, or pomme d'amour* are still the usual names for the tomato in England and Germany. *Pomme d’or* (gold apple) was likewise one of the synonyms of the tomato, indicating that yellow was the color of the fruit of the first imported plants (varieties with yellow fruit).

“In France the name tomato has generally prevailed over these poetic synonyms. This word appears under the form *tomatl* in the Nahuatl tongue spoken by the ancient Mexicans. It is composed of a radical *toma*, of obscure signification, perhaps said of a fruit, combined with the suffix *tl em-“

*Gibault, Georges. Histoire des Legumes, 1912.*
ployed in the Aztec language to form substantives. We have received the word from the Spanish as they write it, *tomate* or *tomato*. Guillianinus of Padua introduced for the first time the name tomato into scientific nomenclature in 1572."

**The Plant**

The tomato is a tender annual with rather weak stems from 2 to 5 feet in length that instead of standing erect generally bend over or spread out as vines, especially when loaded with fruit. It has many irregular pinnate leaves, more or less pubescent, inconspicuous yellowish green flowers on short stems, and fleshy fruit with rather large seed cells containing numerous small seeds. Under cultural conditions there has been developed great variation in the shape, size, contour, and color of the fruit, this last varying from light pink to deep red, from straw through yellow to almost orange, and to many shades of purple. The plant is not very vigorous, requiring an open exposure and good cultivation.

The tomato has not suffered from any lack of attention on the part of seedsmen or horticulturists for a large number of varieties have been developed. It was first listed as a garden vegetable in this country by Landreth in 1820 under the designation "Tomato or Love Apple." In 1828, Large Red and Large Yellow were catalogued. In 1847, it is said, "There are six or seven varieties between which there is not much real difference; the common red is equal to any." According to Bailey,* 513 varieties have been listed or given names. Some of the varieties are fairly old but only a small number have had sufficiently distinctive characters to be widely known or grown for more than a few years. The varieties best known at this time are Stone, Chalk's Jewel, Trophy, Earliana, Mariglobe, Beauty, Early Detroit, and Ponderosa.

Unfortunately too much work has been expended upon the size and appearance of the fruit and the habit of the plant from a purely gardeners' viewpoint, and too little on the qualities of the fruit which are in reality the most important in manufacture so that there is still need for better strains. The qualities needed in the fruit for either canning or manufacture of pulp products, and one might include those marketed fresh, are medium size, 2.5 to 3.5 inches in diameter, regular globular shape, a smooth, fairly tough skin, uniformity in ripening, a good clear, dark red color, firm and meaty consistence, small seed cells, and a pronounced tomato flavor inclined to be somewhat acid. Ribbed fruit, flattened fruit with irregular contour, or large fruit 4 inches or more in diameter, are not well suited either for use fresh or in manufacturing operations. The color is important only for its aesthetic effect as the eye is the most sensitive of all our senses, and red is striking and generally pleasing. A firm skin is needed for protection against decay, and sufficient solids in the meat to give volume and a body which will not break down into watery juice.

The tomato is receiving as much attention at the various experiment stations as any other plant, but unfortunately without close co-ordination between horticulturist and food technologist to the end that the crop may better meet the needs of the food manufacturer.

---

Culture

In the North, the plants are started under glass early in the spring in order to get the advantage of a long season, and later, when the plants are about 5 or 6 inches high, are set 4 feet apart in rows about 5 feet apart, though this spacing varies somewhat with the variety, soil, and locality. Fruit begins to mature about the middle of August and continues until frost. The yield averages less than 4 tons per acre, though under good cultivation may exceed 10 tons per acre. On the West Coast where the season often runs into late November, the yield averages much higher, under exceptional conditions reaching 15 tons per acre. The plant is subject to attack by both insects and plant parasites, but these have been studied to the end that preventive and remedial measures are available to hold them in check, at least to a marked degree.

The tomato is grown generally in kitchen and market gardens over the entire country; in large acreage in the South, especially for early shipments to northern markets; in New Jersey, Delaware, Maryland, and Virginia on the East Coast; Pennsylvania and New York in the northeast section; Ohio, Indiana, Illinois, Michigan, Kentucky, and Missouri in the central States; and California on the West Coast for canning and manufacturing products. Considerable quantities of fresh fruit are also brought in from Mexico during the winter season.

Quantity Produced

The tomato has a most varied culinary use which accounts for the enormous quantities grown. It is used as a salad, stewed, cooked with other ingredients, prepared as soup, in dressings as ketchup, chilli sauce, and other sauces, pickles, preserves, etc., and the juice as a beverage. It is one of the most wholesome fruits and has been made popular by the teaching of dietitians and food experts, and is coupled with the orange as a source of vitamins. It is grown so as to be upon the market the greater part of the year, the field production being augmented by enormous shipments from the South, Mexico, the West Indies, and by greenhouse culture. The importation from Mexico and the West Indies amounted to 122,000,000 pounds valued at $3,835,000 in 1928.

A better conception of the relative importance of the tomato is gained from the statistics available upon the manufactured products. In 1900, the tomato pack amounted to 5,495,000 cases, which represented 55 per cent of the total pack of all vegetables and 47 per cent of their value. In 1925, which was the banner year for production, canned tomatoes amounted to 19,770,000 cases; purée, 3,626,000; paste, 622,000; and sauce, 580,000 cases; a total of about 24,500 carloads. In 1928, which was an exceptionally low year in production, the total was only 8,538,000 cases of canned tomatoes, the imports, mostly from Italy, rose to 92,732,000 pounds canned valued at $5,200,000 and 9,817,000 pounds of paste, valued at $1,054,000. The importation, which seems large, was not nearly enough to bring the supply up to that of 1925. Such figures are interesting even though they are not comprehensible, nor are they as large as they are likely to be when the consumer learns that for 15 or 20 cents the equivalent of about three pounds of vine ripened fruit can be purchased in a can or jar instead of green fruit, box colored, at from 15 to 40 cents per pound, depending upon the season of the year.
The tomato ranks first in volume among canned fruits or vegetables, considering the regular form and various preparations. The volume of the regular pack is shown in the following table.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1891</td>
<td>3,322,000</td>
<td>1914</td>
<td>15,222,000</td>
</tr>
<tr>
<td>1892</td>
<td>3,223,000</td>
<td>1915</td>
<td>8,469,000</td>
</tr>
<tr>
<td>1893</td>
<td>4,300,000</td>
<td>1916</td>
<td>13,142,000</td>
</tr>
<tr>
<td>1894</td>
<td>6,456,000</td>
<td>1917</td>
<td>15,076,000</td>
</tr>
<tr>
<td>1895</td>
<td>4,034,000</td>
<td>1918</td>
<td>15,882,000</td>
</tr>
<tr>
<td>1896</td>
<td>3,383,000</td>
<td>1919</td>
<td>10,809,000</td>
</tr>
<tr>
<td>1897</td>
<td>3,964,000</td>
<td>1920</td>
<td>11,368,000</td>
</tr>
<tr>
<td>1898</td>
<td>5,652,000</td>
<td>1921</td>
<td>4,017,000</td>
</tr>
<tr>
<td>1899</td>
<td>7,154,000</td>
<td>1922</td>
<td>11,538,000</td>
</tr>
<tr>
<td>1900</td>
<td>5,495,000</td>
<td>1923</td>
<td>14,672,000</td>
</tr>
<tr>
<td>1901</td>
<td>4,268,000</td>
<td>1924</td>
<td>12,519,000</td>
</tr>
<tr>
<td>1902</td>
<td>9,282,000</td>
<td>1925</td>
<td>19,770,000</td>
</tr>
<tr>
<td>1903</td>
<td>10,157,000</td>
<td>1926</td>
<td>9,455,000</td>
</tr>
<tr>
<td>1904</td>
<td>8,516,000</td>
<td>1927</td>
<td>13,137,000</td>
</tr>
<tr>
<td>1905</td>
<td>5,576,000</td>
<td>1928</td>
<td>8,538,000</td>
</tr>
<tr>
<td>1906</td>
<td>8,361,000</td>
<td>1929</td>
<td>14,145,000</td>
</tr>
<tr>
<td>1907</td>
<td>12,918,000</td>
<td>1930</td>
<td>16,997,000</td>
</tr>
<tr>
<td>1908</td>
<td>11,497,000</td>
<td>1931</td>
<td>9,573,000</td>
</tr>
<tr>
<td>1909</td>
<td>10,984,000</td>
<td>1932</td>
<td>16,950,000</td>
</tr>
<tr>
<td>1910</td>
<td>9,235,000</td>
<td>1933</td>
<td>11,986,000</td>
</tr>
<tr>
<td>1911</td>
<td>9,749,000</td>
<td>1934</td>
<td>13,108,000</td>
</tr>
<tr>
<td>1912</td>
<td>14,022,000</td>
<td>1935</td>
<td>15,381,000</td>
</tr>
<tr>
<td>1913</td>
<td>14,206,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Composition**

The tomato does not rank high in food value as measured by its chemical constituents but has been found to be one of the best sources for vitamins, particularly for vitamin C, the one concerned with stimulating growth in the young and general maintenance of health in the adult. Tomato juice compares favorably with orange juice in this respect. It is most abundant in vine-ripened fruit and, therefore, in larger quantity in the canned product than in the fresh which has been picked green and colored in boxes. Probably no other source is equally economical, and this accounts in part for the large increase in use during the past six years. A very minor usage, but one in line with its healthful effect is the drinking of the juice to relieve thirst where the water supply is of questionable character. Soldiers are provided with canned tomatoes for this purpose and they are also issued in cases of dearth of potable water to avert trouble.

The chemical composition of canned tomatoes as given by Wiley in "Foods and Their Adulteration," is as follows:

<table>
<thead>
<tr>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Fiber</td>
</tr>
<tr>
<td>Starch and sugar</td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Ash</td>
</tr>
<tr>
<td>Salt</td>
</tr>
</tbody>
</table>

**Variation in Quality**

The tomato as used in canning and manufactured products shows marked differences in the character of the fruit in different varieties and also in the same variety during the season. Every observing canner or pulp
manufacturer has noted these factors in the number of cans he can get from a ton, but withal there are little exact data to show the differences. Strasburger and Shaw reported work upon pulp manufacture the gist of which is as follows:

Tomato pulp was made in 200 gallon jacketed kettles under practically constant conditions throughout a season, four varieties being used: Earliana, Chalk's Jewel, Beauty, and Early Detroit. The batch in each case was 145 gallons except for the Beauty, which was 140 gallons owing to the fact that more foaming occurred than with the other varieties. The yield when reduced to the same specific gravity (1.035) was as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Earliana</td>
<td>145</td>
<td>75</td>
<td>52</td>
<td>60</td>
<td>41</td>
<td>46.50</td>
</tr>
<tr>
<td>Chalk's Jewel</td>
<td>145</td>
<td>90</td>
<td>62</td>
<td>75</td>
<td>52</td>
<td>57</td>
</tr>
<tr>
<td>Beauty</td>
<td>140</td>
<td>95</td>
<td>66</td>
<td>70</td>
<td>50</td>
<td>58</td>
</tr>
<tr>
<td>Early Detroit</td>
<td>145</td>
<td>75</td>
<td>52</td>
<td>55</td>
<td>38</td>
<td>45</td>
</tr>
</tbody>
</table>

Differences of 27 per cent between the highest and lowest yield in varieties in the early, and 30 per cent in the late period, and of 15 per cent in the same variety between the early and late periods are so great that it is strange that so few figures are available. These figures tell in a few words the need for studies upon varietal development based upon results obtained in the factory and as a basis for the purchase of raw materials.

In the same work, attention was given to color and flavor as these two qualities are important in products like ketchup. Taking the varieties in the same order, Earliana was judged first on color and fourth on flavor; Chalk's Jewel, second on color and first on flavor; Beauty, fourth on color and second on flavor; and Early Detroit, third on color and third on flavor.

"From these results it can readily be seen that there is no definite relationship between color and flavor in tomatoes of different varieties. Earliana gave the best colored pulp, yet produced the least desirable taste. Chalk's Jewel was without doubt the most desirable variety."

Another observation in this work was "that the sugars and natural occurring mineral salts are at their maximum in the first tomatoes that fully mature on the vine. Daily variation was slight in most instances until after the peak of the season, when the diminution of the sugars and mineral content manifested itself by a falling off in yield."

Cruew and Saywell\(^1\) reported that they had made tests for total solids and acidity upon tomatoes during a period of four years. They found wide variations within the same variety during the season and in different years as well as variation among varieties. One might reasonably expect greater variations in California than in other states owing to the wide differences in temperature conditions in the growing sections, to the effect of irrigation and non-irrigation, and to the long bearing season. The figures show as low as 4.56 per cent total solids with .26 per cent acidity to as high as 9.55 per cent total solids with .72 per cent acidity while the average for the entire state in 1925 and 1926 was 6.03 and 6.09 per cent for total solids and .41 and .44 per cent for acidity. They made a subsequent report in 1933 confirming the previous work.

---

\(^1\) Cruew, W. V. and Saywell, L. G. The Canner, Oct. 20, 1928.
Figures of a similar character were published by the writer in 1915, the work having been done in Indiana. "The tomato will vary in solids from less than 5.5 per cent to nearly 8.75 per cent; in soluble solids from less than 3.5 per cent to nearly 6.5 per cent; in sugar from about 2.25 per cent to 4.25 per cent; and in acidity from .3 per cent to .6 per cent."

Much attention to the composition of the tomato, especially the percentage of the different parts in a number of varieties and at different times in the season has been given by J. H. MacGillivray. The data was obtained primarily as a basis for the improvement of varieties but is equally valuable in explaining the variations in quality and quantity of the yield per ton of fruit during the season. The work goes into more detail than have others.

Canning

The canning of the tomato is as old as the art itself for it was one of the products packed by Appert in his experiments, and a few years later was packed in this country by William Underwood, the pioneer canner of Boston. The latter obtained seed from England in order to get started. It was also one of the first products to be packed on the Pacific Coast when the industry was started by Francis Cutting. It seems queer that a fruit so little known to most persons at that time should have received so much consideration. It is also of interest that in each case the product was really a heavy purée and was packed in glass bottles, as the object was to get as much tomato in the container as possible, for bottles were scarce and costly, and the tin can was available only where it was made by hand.

The credit for packing tomatoes, that is, whole or broken fruit in tin containers, belongs to Harrison W. Crosby, steward at Lafayette College, Easton, Pennsylvania, in 1847. His tomatoes were first stewed in a kettle and then put in the can, and accounts in the early grocery journals refer to "stewed tomatoes" in cans so that the method must have been adopted promptly by packers and persisted for some time.

Two paragraphs from an article by David B. Skillman throw more light upon this subject.

"It was in this year and in the refectory building that Harrison Woodhull Crosby, assistant steward, instituted the great industry of preserving vegetables and fruit in hermetically sealed tin cans. In September, 1847, he made his first experiment. He secured six little tin pails, such as children play with on the seashore. For each of these he prepared a lid and cut a square hole in the center. He then soldered these lids with the hole in them on the tops of the pails. He stewed tomatoes and put the fleshy parts into these pails, through the hole left in the lid. With a piece of tin larger than the hole he soldered this opening shut.

"So fresh and delicious were these tomatoes when he opened the pails the following winter, that he determined to preserve a large number of cans in the following year. He packed a thousand cans. But the product was new and strange. Tomatoes in any form had but recently come into use as human food. He could not sell them. So packing them in boxes containing six cans each, he sent them to newspapers and various famous persons, including Queen Victoria, James K. Polk, then President of the

1 Bitting, A. W. Ketchup. 1915.
United States, various Senators and Congressmen. Letters of acknowledgment, thanks and astonishment, as well as contemporary newspaper accounts, collected by G. Wyckhoff Cummins, M.D., of Belvidere, N. J., fully authenticate these facts. For instance, The New York Tribune in 1849 prints the following:

“Fresh Tomatoes at Christmas. Mr. Crosby of Middlesex, New Jersey, has sent us some fresh tomatoes preserved in tin cans. Whatever the secret of their preparation, we are bound to acknowledge that their preservation has not impaired their flavor. They taste as they would have tasted when plucked from the vines.”

There are two objectives in canning tomatoes: the one aims at getting the maximum of food value so that the tomatoes are packed tightly into the can or jar with more or less breakage, and juice may or may not be added to fill interstices, the other is to have the fruit as nearly like the fresh as possible so the fruit is handled with care to preserve it entire, is selected to pack without crushing, and the interstices are filled with juice from other fruit. One product is suitable for stews and as an ingredient in many dishes where the tomato flavor is desired, so serves for the great majority of culinary operations; the other for salads and where appearance counts. Under the present regulations, it is doubtful whether the latter can be packed legally but there is just as good reason for packing a tomato in its most attractive form as there is for a “fancy” peach or a “fancy” apricot. This is particularly true as vine-ripened fruit is used instead of the immature and sickly box-colored products that are offered on the fresh market without restriction as to labeling when the local products are out of season. One of the finest products packed at the time the present ruling was made consisted of five or six fruit in a can equal to the No. 10 in diameter but only two inches high. Juice was used to fill the interspaces. A light cook was given with the result that the fruit could be served whole or sliced. Pulp, purée, and paste are other forms of packing that have distinctive uses, permitting different degrees of concentration. These are the most economical forms in which to pack the tomato. Pulp and purée are often used as being synonymous but pulp refers to juice freed from seeds, skin, and hard parts, reduced to approximately one-half its volume or a specific gravity of 1.035, while purée is reduced somewhat more or to a specific gravity of about 1.040.

Canning Equipment

The equipment required for the packing of the tomato may be of the simplest kind or it may be extensive and elaborate, depending upon the volume and forms which the products are to take. Fortunately quality does not depend upon the size of the plant or the volume of the output. Packing is done in factories employing more than a thousand persons and in places operating with a dozen, the former using the products of hundreds of acres, and the latter depending upon the picking from small patches, the ultimate result depending upon the skill and care used in its manufacture.

The essentials in equipment for handling tomatoes are: First, a place to sort the fruit for fitness; second, a washer; third, a steam scalding box; fourth, peeling tables; fifth, filling table; sixth, an exhaust box; seventh, a can closing machine; eighth, a cooker; and ninth, a
cooler. The size and kind of these units will depend upon the volume to be handled. Other devices used are conveniences which may be highly economical, though not essential, but reduce hand labor. Many ingenious devices have been made for washing, scalding, conveying, filling tomatoes into cans, reducing them to pulp products, but in the keen competition only a few have survived and become practically standard.

**Harvesting**

The packing of tomatoes begins in the fields with the picking which needs to be done at frequent intervals so that only the mature and well colored fruit be taken. There are no tomatoes so good as the vine-ripened fruit for they have the maximum flavor and to obtain them it may be necessary to pick every day, every other day, or under some conditions at a longer interval. In places where the weather is uniform and irrigation is practiced, an interval of four or five days is possible but the usual result is to have some of the fruit under- and some over-ripe. If the fruit be used at once, then it should be taken without any part of the stem attached, but if to be shipped a considerable distance or stand for a couple of days, there is some advantage in leaving an inch or more of the stem attached as it reduces infection in the exposed tissue at the base of the fruit. This advantage is most pronounced after rains and in hot weather.

The best carrier is the lug box, similar to that used for handling orchard fruits on the West Coast, next is the crate, and the least desirable package is the basket. The lug box is rigid, holds about 40 pounds, and is only about eight inches in depth so that the fruit does not crush from superimposed weight. A cleat over each end makes stacking easy without the bottom of one box coming in contact with the fruit in the next below. Furthermore, it allows fair ventilation. The lumber used needs to be dressed at least on the side next to the fruit. Since crates have been reduced in size so that they can be lifted on and off wagons by one man, they present essentially the same advantages as the lug box. The crate construction permits the use of some lumber not suitable for lug boxes and also cuts down weight where hard woods are used. The basket, if deep and especially if cone shaped, is a poor carrier. Every jounce of a wagon or truck, or hard jolt in starting and stopping a train, tends to wedge the fruit into the bottom with consequent cracks and bruises. Its advantages lie in the low first cost, lightness in weight in shipping, and ease of stacking when empty. It continues to be used mainly in the East.

The filled lug, crate, or basket ought to be delivered to the cannery promptly and not permitted to stand unprotected in the field. At the factory, they can be stacked in rows with from one-half to one foot of space between for ventilation if to be held for a half day or more. Solid stacking to a height of six feet or more favors rise in temperature and deterioration, the rate increasing with the time of holding. The largest yield of finished product can be obtained only by prompt manufacture after the stock is once picked and delivered.

Lugs, crates, or baskets need to be kept clean. Rotten or moldy tomatoes infect the wood with which they come in contact, which in turn serves to inoculate fresh fruit on succeeding trips. The rougher and spongier the wood, the more serious the contamination so for that reason it should be dressed on the inside. No entirely satisfactory method of cleaning has been
devised, but a spray box over a conveyor, using a heavy pressure of water (75 pounds per square inch) will remove a large share of the surface organisms. It is probably the most rapid and economical method for doing the work. Soaking the carriers is to be avoided as it causes the wood to warp and the nails to loosen, unless the drying be done promptly. The most satisfactory spray to act as a germicide is a solution of hypochlorite of soda which may be applied as a spray after washing.

Inspection

Tomatoes are generally purchased upon the basis of weight or ton, though in some places the basket or crate is accepted as a unit.

An inspection is made at the time of delivery by drawing two or more crates from different parts of the load and either turning the tomatoes upon a table and sorting the stock according to grades, or better still, turning them into a tank of water, as in the latter they float and thus all green butts and rots show at a glance, making the separation easier. The culls or fruit below the contract agreement are weighed and deductions in payment made accordingly.

The Bureau of Agricultural Economics of the Department of Agriculture has prepared standards for canning tomatoes which are now generally accepted as the basis for contracts with growers and definitions to be followed in inspection. These are as follows:

"It should be understood at the outset that the only grading required of the grower is the removal of culls. Such tomatoes should be left in the field. It is not intended that the grower sort the tomatoes into No. 1 and No. 2 grades. The proposed grades provide a basis for sampling the tomatoes as they are delivered to the cannery.

The application of these grades requires the services of private or official inspectors to determine the amount of each grade in the various loads of tomatoes. Such inspectors must be capable, efficient, and above all they must be absolutely neutral. The inspector's reports should show the percentages of U. S. No. 1, U. S. No. 2, and Cull tomatoes.

Sorting

The handling of the tomatoes at the factory may be direct from the wagon or truck or, as often happens, from a car or yard, the latter requiring a secondary handling by truck or conveyor. One of the best means for such handling for distances up to 500 feet is a flume with water made to circulate by means of a pump. The tomatoes are handled gently and at the same time are given a good preliminary wash. Another advantage is that it avoids congestion from a great number of boxes or crates.

The first operation in the factory is sorting for quality if the purchase has not been made upon a grade basis, and even in this case it may be profitable. The crate is emptied upon a short belt and the tomatoes not easily peeled due to excessive size, irregularity in shape, green butts, or defective spots, are separated to be used for pulp. Under-ripe fruit can be left in the crates for a couple of days and unfit material discarded before any labor has been expended upon it. If no tomatoes are to be held in crates, it is somewhat easier to sort after washing than before, as defects show more strikingly on the bright fruit. The only change needed in the regular line-up of equipment is some additional space between the washer and
A tomato turning device on the table facilitates the work. A simple one, recommended by the Bureau of Chemistry, consists of short pieces of iron pipe suspended from above by means of wires, the ends of the pipe being kept about an inch above the belt. Tomatoes on coming in contact with the pipes are turned over thus exposing both sides. Another expedient is to divide the conveyor, making a drop of about four inches. Such an inspection gives an exact check upon each delivery and is better than drawing sample crates from the load; it does not require any elaborate system of cost accounting nor is it necessary to carry the items to the fourth decimal place to demonstrate that a very little work at this point eliminates 85 per cent of the sorting on the tables; that each unit of thirty women will do more with from three to five of their number sorting than with all peeling, that the waste will be less and the product better. The mere fact that the sorting in most places is carried in the cost of peeling does not lessen the expense but rather disguises the true amount. The work has to be done and it is only a question of doing it in the best way with the least effort. One effect of sorting that is overlooked is that if only good stock goes to the peelers, more care will be taken than if small, wrinkled, and cracked stock be mixed with the good. The canner who is desirous that the grower deliver upon a grade basis may likewise profit by applying the same principles to factory operations.

Washing

Washing is a most important operation whether it be done before or after sorting, and particularly so for tomatoes intended for juice, pulp, ketchup, sauce, and paste. If the tomatoes are from clay land or adobe fields and have become dirty because of rains, a short preliminary soaking is advantageous in loosening the adherent dirt so that it is more easily removed under sprays of water in the washer. The fruit needs to be delivered in a single layer under the sprays to get the maximum effect. The period when the fruit could be conveyed through a tank or trough of water, made wet and look bright, has passed. It is comparatively easy to arrange pipes with jets directed so that every part of the tomato be acted upon and simple pumps are available to increase the pressures to any degree necessary for cleaning. Rotary washers are too rough in the handling of fruit for canning, though they are preferred for that which is to be made into pulp.

The fault with much of the washing is that the fruit is not exposed to sprays for a sufficient length of time and the conveyor crowded with several layers so that those on the inside are not properly treated.

Scalding

The tomato has a very thin skin and by subjecting it to the action of steam or scalding water for a brief period it contracts and separates from the tissues immediately underneath. The hotter the treatment, the better, for the time can be made so short that the heat does not penetrate into the flesh and cause softening. The separation of the skin is aided by sudden chilling with water, as by sprays, and this has a secondary effect in cooling the tomato and thus aids in the subsequent handling. These considerations have led to making the washing, scalding, and cooling successive operations in the same machine or upon the same conveyor belt. The uneconomic feature is that the steam cannot be confined to a certain part and not be dissi-
pated. By having the pipes with numerous small openings close to the tomatoes, the work can be well done. The chilling is accomplished by the same sort of mechanism as the washing.

Scalding was formerly done by putting the tomatoes in baskets and submerging them in hot water and while the method is effective in removing the skin and economical as regards fuel, it is not the best way. The bath frequently falls below a proper operating temperature, the tomatoes are heated and softened more than is desirable, but more objectionable than either of these is the fact that the water becomes dirty and is not changed at sufficiently short intervals. A steam chamber can be built simply and economically and trays used to hold the fruit while being treated. Such apparatus is suitable for small establishments and, therefore, no excuse exists for the old type of scalder.

The time required for scalding depends upon the ripeness of the fruit and the variety but should be no more than is necessary to loosen the skin. The water scalding time was generally from one to one and one-half minutes. According to the figures given for the rate of belt travel on continuous washers and scalers, the time for steam scalding varies from one-fourth to one minute, with the majority working toward the lower limit. A machine having a conveyor 24 inches wide and the same number of working feet in length has a capacity of about 6 tons per hour and requires from 20 to 25 horsepower boiler to supply the necessary steam.


A recent patent provides for carrying tomatoes on the usual conveyor through a tunnel with four compartments. In the first the tomatoes are subjected to wet steam under about five pounds pressure; in the second they are subjected to superheated steam brought to about 500° but under only ten pounds pressure; the third compartment provides the same conditions as the first, and the fourth is supplied with cold water under pressure to wash away the disintegrated skin. The second compartment being under the higher pressure does not permit air to enter and therefore no carbonization occurs.

Distributing the Tomatoes

As tomatoes will not stand rough handling after being scalded, it is important to get the fruit to the peelers promptly and in small units so as not to retain heat nor cause softening. There are two general systems for handling the fruit; in buckets or pans or conveyors or merry-go-rounds, and directly upon belts to special peeling tables provided with bins and means for caring for the waste. In small plants, the pans or buckets may be distributed directly by hand or on rack-wagons built for the purpose. For simplicity, cleanliness, and adaptability to both large and small operations none is better than handling the fruit in 12 to 14 quart oval pans. These present decided advantages over the 14 quart pail which has been used a great deal in the past, in that the heat radiates more freely from the large surface and the bottom layers are not softened to the same extent by the superimposed weight. The oval shape requires less width on the tables than does the round pan, is more convenient for the peelers, but does not stack quite so easily. The pans with scalded fruit can be carried on a merry-go-
round or on a conveyor and be drawn by the peelers as they pass, or be set off by someone to do that work.

**Peeling Table**

A simple table serves the purpose very well if the peeling be done directly from one pan into another, the waste remaining in the first or dropped through a hole or spout into a pan set on a shelf below. Where there is plenty of room, the peeler may work with three pans, using the middle one for waste, which is preferable to leaving the waste in the delivery pan. The pans are returned to the conveyor to be carried to the filling table and the waste to a point for its disposal. Where a belt conveyor is used, the return flight is generally made to carry either the peeled fruit or waste. The pan system gives ample opportunity to inspect the peeled fruit and waste from each worker. The empty pan is run through a spray box before re-use and, therefore, provides the best condition for cleanliness. In this respect it is superior to any special peeling table yet devised. The table top is made to have a slight backward incline so that any juice which escapes in the handling tends to run from the worker and not toward her.

The delivery of tomatoes from the scalders upon a conveyor belt that carries them directly to the tables is one of the developments in volume production. The belt runs along the back edge of the table top or between two tables. Bins are built into the table for each peeler, and a gate just above the belt acts as a deflector to divert the tomatoes into the bin. When the tomatoes are not graded before scalding, it is usual to have the conveyor covered so that the peelers cannot see what is on the belt, otherwise they are prone to select the good stock and let the less desirable pass. When preliminary sorting is done, the difference in the fruit is not so great as to make selection an objective. A separate bin is provided for the peeled fruit in order that inspection can be made of both the volume and kind of work done before it is discharged upon a conveyor to be carried to the filling table. The waste is discharged upon the return flight of one of the conveyors, or better upon an independent unit to be carried to some convenient point. This style of equipment permits the handling of a large volume of material with the minimum expense for labor but the percentage of waste is somewhat higher and there is difficulty in keeping the equipment clean.

In order that all the peelers may fare alike in such a system, they can move one bin nearer the head each day or after each starting period. The last one or two in the row are generally at some disadvantage in receiving either a constant supply or choice fruit and changing positions equalizes any handicaps.

**Peeling**

Peeling seems to be such a simple operation that apparently anyone should be able to do the work, but the fact remains that when tomatoes cost fifteen dollars per ton, some persons would be costly if they worked without wages. The better peelers hold the fruit in the palm of the left hand, stem end in, the skin is started by a nip at the center, and by three or four dextrous pulls it is slipped to the base, the fruit turned over, and the core cut out without opening the seed cells. The loss on peel and cores on good smooth fruit amounts to about 20 per cent, whereas on peeling the field run, it averages nearly 40 per cent. This means a substantial saving on properly
graded fruit as there is less loss on the part converted directly into pulp and also a lessened cost for labor on that part. There are no figures available to show the net yield of products in the two systems nor the labor costs.

The peeling is generally done upon a piece basis, using the 14 quart pail as the unit of measure. Peeling ability varies greatly, from 30 to 40 buckets for an eight hour day being the usual run. It requires about 100 peelers to keep a one-line plant in continuous operation.

In order to make the highest possible daily wage many peelers cut and slash the fruit unnecessarily, thus not only marring the appearance but adding to the waste. Another short cut is to crush the small and irregular fruit to save time in peeling. This phase of waste attracted little attention when tomatoes were around seven dollars per ton but with the advance in price, it has taken on a new meaning. Studies have been made upon wastage by individuals in peeling given amounts of stock and also of the amount peeled per day. The variations are surprisingly wide, but out of the studies the recommendation has been made that payment follow a bonus system, the person peeling well with the least waste to be rewarded with an increase in wages proportional to the saving. Where tried, it has had the effect of raising the standard of peeling and of lowering costs. One of the earliest attempts in this direction was to sell the buckets or pans of scalded tomatoes to the peelers at one cost and to buy them back at an advance, those showing the least loss profiting accordingly.

Various mechanical devices have been tried for removing the peel but none has been entirely successful. These inventions include subjecting the tomato to a very high heat while passing quickly through a furnace, the object being to roast the skin so that it could be washed off; lye peeling; scarifying the surface before scalding in steam; scalding and then spraying under strong jets; brushing the scalded fruit; using vacuum suction to remove the skin; air blast; and puncturing the skin with electric sparks. After the mechanical treatment, the tomato has to be gone over by hand to remove the core, corky cracks, green butts, and adherent bits of skin so that the saving in labor has not been all that has been claimed or expected. The importance of careful coring has been emphasized since tomato juice has become an important commercial item. The core, if not removed, imparts some bitter flavor to the fruit during the cooking. Machines have been developed which do this work speedily and fairly well but none equal good handwork.

**Filling**

The method of filling employed is usually made dependent upon the volume or grade that is being handled. In small plants hand-filling may be done directly from the pans at the rate of about 200 cans per hour for the No. 2½ or smaller size. If one of the simpler forms of fillers, such as the rotary filling table be used, the speed can be increased to 700 cans per hour and from one to four persons work at a table. For hand-filling, it therefore requires from as many as thirty to as few as eight persons to keep one line operating at the rate of 100 cans per minute. A larger number is required for a strictly fancy pack. In the large factories, machine-filling is the rule where one operator can handle two machines filling 3,000 cans per hour. This can be used on standards but not on the strictly fancy grade since more fruit is broken and crushed than in hand-packing.
The figures for the number of persons required for filling for one line under the different conditions are probably close enough to estimate the difference in costs.

In solid pack tomatoes the fruit is packed as closely as possible in the can and enough above the level so that after exhausting, the topping plunger will squeeze the fruit together and make a full can. Such hand-packed cans need to be filled to the desired weight, otherwise variations occur in the headspace with resultant danger of over-weight in some and slack fill in others. In machine-filling, the tomatoes are first fed into a measuring chamber a little larger than the can and are then forced into the can by a plunger. This is the style of packing formerly most used, no juice being added at any stage.

In order to avoid the crushing of the fruit inherent in the solid pack, the cans are filled closely but without mashing and the spaces between the fruit filled with juice. This gives a distinctly better appearance with only a slight reduction in the fibrous matter as the juice has almost the same composition as the whole tomato. The amount of juice permitted is limited to that which normally escapes from the preparation of the tomatoes. According to a Regulatory Announcement: “This is the article which the purchaser expects to receive under the name ‘canned tomatoes,’ and is the only article entitled to that name without qualification.”

This style of packing may be done either by hand or by machine, the difference being that the cans are not filled as tightly with fruit and the juice is added to fill the interstices. It is the one followed in making fancy grades where in addition the fruit is selected for its high quality, uniform color, and perfection of workmanship in peeling and coring.

Tomatoes with purée added is a style of packing developed on the West Coast to make use of the excess pulp derived from certain varieties which either become excessively large, or have a high percentage which are too irregular to peel well. The extra large and irregular fruit are made into pulp and concentrated to a little less than one-half its volume, which is fairly heavy and designated a purée. A No. 2 1/2 can receives first one pound of fruit and the balance purée. This gives higher total solids than does straight packing; it is equally as good as the solid pack for many purposes, but for some others it is not so satisfactory. Such a product must bear a proper qualifying label and if the purée be from trimmings, that fact must also be disclosed.

The tomato is most often packed without any seasoning though the addition of a small quantity of salt and sugar is considered an improvement by many persons. A mixture is made of one part salt to two parts sugar and a well rounded teaspoonful of the mixture placed in a No. 2 1/2 can just before the tomatoes. This is sufficient to take the edge off the acidity in the finished product and accentuate the other tomato flavor.

Exhausting

The tomato needs to be well exhausted and preferably for a rather long time at a moderate temperature (180° F.). This produces less softening and collapsing of the tissue than a shorter exhaust near the boiling point, and, therefore, the contents present a better appearance when the can or jar is opened. Six or seven minutes at 175° produces a temperature of 135°
or more in the can, enough for a good vacuum, and 145° to 150° insures against over-filling. The tomato is not hard on the can in the production of pinholes, but attacks the iron to the extent of causing an astringent and somewhat bitter taste. A good exhaust holds this activity in check.

Cooking

The tomato being a moderately acid fruit is not difficult to sterilize, the troubles experienced are due to irregularities of heat penetration in the can rather than from any especially resistant organism present. The agitating cooker is the ideal one. A slow gentle rolling of the can permits the heat to penetrate to all parts in the shortest possible time and without excessive heating of the material next to the can wall. A rolling motion of less than $7\frac{1}{2}$ revolutions per minute was found to be insufficient or uncertain in tightly packed fruit since the mass might turn as a whole in the early stages, and a speed greater than 15 revolutions per minute showed the effects of the movement. From 10 to 12 revolutions gave the best results. In the desire for capacity, it is not infrequent that cookers are run at speeds above that which preserves the best appearance. The time for cooking No. 1 and No. 2 cans in the agitating cooker is 10 minutes at 212°, for No. 2½ and No. 3 cans, 15 to 16 minutes, and No. 10 cans, 25 minutes, except on the West Coast where 33 per cent additional time is needed. Sterilization can be effected in even less time but not with safety owing to irregularities in packing.

Tomatoes may be cooked in the open bath and that has been the regular custom in the East. The time is 30 minutes for the regular No. 2 can, 40 to 45 minutes for No. 2½, 45 to 50 for the No. 3, and 60 to 70 minutes for the No. 10 at 212°, if they have been well exhausted previous to going into the bath and if not cooled after coming out. If the cans be cooled, which is the better practice, an additional 5 minutes is given in the cooking. If the cans be turned on the side instead of standing in the normal position in the bath, the cooking time may be cut from 15 to 20 per cent with safety. In the West, the tomato requires a heavier cook, five to ten minutes or more may be added to the time in the standing bath but for safety the temperature is increased to 220° F. for No. 2½ and No. 10 cans, especially if purée be added.

The great bulk of tomatoes is packed in No. 1, No. 2½, and No. 10 cans. The No. 3, which was the standard for many years, has been almost completely superseded by the No. 2½. Plain tin is generally used.

Cooling after cooking is essential if the careful work of the earlier steps is to be conserved. The structure, color, and flavor are all affected unfavorably by prolonged heating which are shown in their most aggravated form in stack burning, soupy condition of the contents, brownish color of the fruit, astringent taste, and galvanized appearance on the inside of the can. The cooling should proceed at least to the point where only sufficient heat remains to dry the surface to prevent rusting.

Tomato Combinations

The tomato is frequently packed in combination with other vegetables as tomatoes and green chillies, tomatoes with sweet peppers, tomatoes with okra, and tomatoes with whole grain corn. In packing with peppers, the latter may be whole, cut in strips, or chopped. A tablespoonful of the
pepper is added to a No. 2 or No. 2½ can. In packing with okra or corn, the proportions are about two-thirds tomato and one-third of the other product. The cook follows that of okra or Maryland style of corn where those are parts of the combination, and for peppers when the peppers are used. Combinations are most often packed in No. 2 cans or smaller.

**Label Weights**

(Sp. Gr. 1.02). 8Z Short, 7½ ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 10 ozs.; No. 300, 14 ozs.; No. 1 Tall, 15½ ozs.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz. No. 5, 3 lbs. 7 ozs.; No. 10, 6 lbs. 6 ozs.

**UNITED STATES STANDARDS FOR GRADES OF CANNED TOMATOES**

(Approved January 16, 1933)

**Definition**

Canned tomatoes are the canned vegetable prepared from sound, ripe, fresh tomatoes, of any red variety or varieties, by thoroughly washing and scalding, and by proper peeling, coring, and trimming, with or without the addition of sugar and/or salt, packed in hermetically sealed containers, and sterilized by heat. The liquor used for filling the spaces between the vegetables is the natural juice of the tomatoes and does not exceed in quantity the juice derived, during proper peeling, coring, and trimming, from the tomatoes in the can. However, the juice of other tomatoes of the same quality and preparation may be used, provided the total quantity of juice is not increased, except as hereinafter provided.

**GRADES OF CANNED TOMATOES**

**U. S. Grade A (fancy)** canned tomatoes are select tomatoes which are whole or almost whole; are of uniformly good red color; are practically free from pieces of skin, cores, blemishes, and other defects; possess the typical flavor of naturally ripened tomatoes; and score not less than 90 points when scored according to the scoring system outlined herein; provided, that only one factor may have a rating in and not below the range of 15 to 17 points.

**U. S. Grade B (extra standard or choice)** canned tomatoes are canned tomatoes which are whole or in large pieces; red in color; and practically free from under-colored parts, pieces of skin, cores, blemishes, and other defects; possess a desirable flavor; and score not less than 75 points and need not score more than 89 points when scored according to the scoring system outlined herein; provided, that but one factor may have a rating in the range of 12 to 14 points.

**U. S. Grade C (standard)** canned tomatoes are canned tomatoes which need not be whole, but consist of fairly large pieces; are reasonably free from under-colored parts and from pieces of skin, cores, blemishes and other defects; possess a fairly good flavor; and score not less than 60 points and need not score more than 74 points when scored according to the scoring system outlined herein.

**Off-Grade Quality (substandard)** canned tomatoes are canned tomatoes which fail to meet the requirements of the foregoing grades, or, when any one of the grading factors falls into the subdivision D, or, which fall below the standard promulgated under the terms of section 8, paragraph 5, of the Food and Drugs Act.

**Note.**—Certificates of grade issued under the United States Warehouse Act or the Farm Products Grading Law covering canned tomatoes falling below the standard promulgated under the terms of section 8, paragraph 5, of the Food and Drugs Act, must bear the legend required under that act in the space for "Remarks."

**PREREQUISITES TO GRADING**

**Condition of Container**

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents, and the ends shall be flat or concave.

**Condition of Package and Label**

If cased, the canned tomatoes shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean, and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Food and Drugs Act.
Fill of Container

Cans of tomatoes will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container, and if the packing medium is not in excess of the quantity necessary for proper processing without impairment of quality.

A certificate of grade covering canned tomatoes that do not meet the above requirements shall bear the legend, "Below U. S. Standard"

"Slack Fill"

A certificate of grade covering canned tomatoes that do not meet the above requirement in that the packing medium is excessive, whether or not the head space is excessive, shall bear at least the 2-line legend

"Below U. S. Standard—Slack Fill"

"Contains Excess Added Liquid"

Provided, That when peeled and cored whole tomatoes are packed and processed in such a manner as to retain the tomatoes in a practically whole condition when opened, the liquid is not considered excessive when there is added the juice of other peeled, cored, and trimmed tomatoes in quantity not exceeding that necessary to fill the interstices.

The following table indicates the dimensions and names of containers most commonly in use. The last column indicates the maximum head space allowance to meet the above requirements.

<table>
<thead>
<tr>
<th>Can Size</th>
<th>Maximum capacity in water at 68°F (in ounces)</th>
<th>Maximum head space allowable (measured from top of double seam in 16ths of an inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8Z Short</td>
<td>7.93</td>
<td>7.2</td>
</tr>
<tr>
<td>8Z Tall</td>
<td>8.68</td>
<td>7.6</td>
</tr>
<tr>
<td>Picnic (No. 1 eastern)</td>
<td>10.94</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 300</td>
<td>15.22</td>
<td>9.5</td>
</tr>
<tr>
<td>No. 300x</td>
<td>15.69</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 1 Flat</td>
<td>8.23</td>
<td>6.4</td>
</tr>
<tr>
<td>No. 1 Short</td>
<td>14.02</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 1 Tall</td>
<td>16.70</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 303</td>
<td>16.88</td>
<td>9.4</td>
</tr>
<tr>
<td>No. 2 Flat</td>
<td>9.21</td>
<td>6</td>
</tr>
<tr>
<td>No. 2 Squat</td>
<td>13.50</td>
<td>7.4</td>
</tr>
<tr>
<td>No. 2 Short</td>
<td>17.79</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 2 Special</td>
<td>20.25</td>
<td>9.6</td>
</tr>
<tr>
<td>No. 2</td>
<td>20.55</td>
<td>9.7</td>
</tr>
<tr>
<td>No. 1¼ Special</td>
<td>13.38</td>
<td>6.1</td>
</tr>
<tr>
<td>No. 1½</td>
<td>13.81</td>
<td>6.2</td>
</tr>
<tr>
<td>No. 2½</td>
<td>29.79</td>
<td>9.9</td>
</tr>
<tr>
<td>No. 3</td>
<td>35.08</td>
<td>10.2</td>
</tr>
<tr>
<td>No. 10</td>
<td>109.43</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Addition of Tomato Products

Certificates of grade covering canned tomatoes that fail to conform to the definitions hereinbefore mentioned, in that they contain added tomato products, shall bear a special explanation statement to indicate the fact as, for example, "Tomatoes with puree from trimmings."

ASCERTAINING THE GRADE

The grades of canned tomatoes may be ascertained by considering the following factors: Percentage of whole tomatoes, solidity, color, absence of defects, and flavor. The relative importance of each element has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
<th>I. Percentage of whole tomatoes</th>
<th>II. Solidity</th>
<th>III. Color</th>
<th>IV. Absence of defects</th>
<th>V. Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Total ........................................... 100
Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 12 to 14 means, 12, 13, and 14.

I. Percentage of Whole Tomatoes
(A) To receive a rating within the highest group, 18 to 20 points, for this factor, the tomatoes must all be whole or practically whole. Tomatoes that score below 18 for this factor may not be graded U. S. Grade A, or fancy.
(B) If the majority of tomatoes are whole or in large pieces, from 15 to 17 points may be allowed.
(C) If the pack consists of fairly large pieces, from 12 to 14 points may be allowed. Tomatoes that fall in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.
(D) If tomatoes are in small pieces, from 0 to 11 points may be allowed.

II. Solidity.—The factor of solidity refers to the proportion of tomato meat to the juice present. Consideration shall not be given under this factor to the percentage of whole tomatoes in the can. The rating for this factor shall be based on the percentage of tomato meat after draining the sample over a screen containing two meshes to the inch for two minutes. The wire of the screen must be uniform in diameter, not less than 0.04 nor more than 0.07 inch. No. 2½ size cans and smaller are drained over a screen of the above description 8 inches in diameter; No. 3 size cans and larger over a screen 12 inches in diameter.

Cans of tomatoes that contain drained weights less than 50 per cent of capacity shall be given a credit of 0 to 11 points, determined by deducting 1 point for each 4½ per cent deficiency in drained weight.

III. Color.
(A) Canned tomatoes that have a uniformly good red color may be given a credit of 18 to 20 points for this factor.
(B) If a good red color predominates, but a few under-colored parts or areas are present, a credit of 15 to 17 points may be allowed.
(C) If red is the predominating color but the tomatoes possess a considerable number of under-colored parts, they may be considered of only fair color and may be given a credit of 12 to 14 points. Tomatoes that fall in this classification shall not be graded above U. S. Grade C, or standard, regardless of the total score for the product.
(D) If the color is pale or off-color in whole or large part, from 0 to 11 points may be allowed.

IV. Absence of Defects.—The factor of absence of defects refers to skins of tomatoes, the cores or portions thereof, and blemishes of all kinds, including scars and brown- or black-colored portions.
(A) To receive a rating within the highest group, 18 to 20 points, for this factor, the product must be practically free from the defects mentioned.
(B) If the defects are inconsequential and the product is reasonably free from defects, a credit of 15 to 17 points may be allowed.
(C) If the product is only fairly free from defects, a credit of 12 to 14 points may be allowed.
(D) If the defects are in excess of the standard for canned tomatoes promulgated under the Food and Drugs Act, from 0 to 11 points may be allowed.

V. Flavor.—The quality of flavor of canned tomatoes shall be classified from the standpoint of palatability.
(A) To receive a rating within the highest group, 18 to 20 points, for this factor, the tomatoes must have an especially fine, clean, typical, properly ripened tomato flavor, with the aroma very fully developed and especially pleasing to the taste and smell.
(B) Tomatoes that have a typical, desirable flavor but are lacking somewhat in the highly pleasing characteristics, may be given a credit of 15 to 17 points.
(C) Tomatoes that possess a palatable flavor may be given a credit of 12 to 14 points. Tomatoes that fall in this classification shall not be graded above U. S. grade C, or standard, regardless of the total score for the product.
(D) If the tomatoes possess an objectionable or distinctly disagreeable flavor, from 0 to 11 points may be allowed.

Your letter inquiring as to the attitude of the bureau regarding the sale of tomatoes with purée is at hand.

It is the understanding of the bureau that the term "purée" implies a certain degree of concentration. A product consisting mainly of tomato pulp which has been put through a cyclone or a cyclone and finishing machine would hardly be entitled to the name "purée."

There appears to be no objection to the sale of tomatoes with purée made from trimmings under the label "Tomatoes With Purée," provided the statement that the product is made from trimmings is printed in a conspicuous manner.

One label has come to the attention of the bureau which bears the legend "purée from Trimmings with Tomatoes" on the face, while the other face bears a picture of a whole tomato, above which is printed the name of the brand and below the name of the canning company. Such a label is not regarded as proper, but no objection will be made to it if the legend "Purée from Trimmings with Tomatoes" is also printed across the face bearing the picture of the tomato.


The department announced in Food Inspections Decision 144, issued May 27, 1912, that canned tomatoes containing added water were regarded as adulterated within the meaning of the Food and Drugs Act. Notwithstanding this announcement, it has been necessary to bring prosecution in numerous cases in which canned tomatoes were found to have been adulterated with water.

It has come to the attention of the bureau that certain tomato canners were unwittingly diluting the tomato juice used in canning their products through the employment of improper factory methods. In some factories the juice was heated with an open steam coil or by live steam in some form. This always results in a dilution of the juice through a condensation of steam. In other establishments the juice is elevated by one or more steam siphons. Unless great care is used in this practice, steam will be condensed, with a resulting dilution of the juice.

The bureau will continue to regard as adulterated canned tomatoes containing added water from any source, and this notice is issued to canners in order that they may take proper precautions to modify their processes in such a way as to obviate possible dilution of their product through the use of faulty factory methods.

S. R. A. 354. Labeling of Canned Tomatoes With Pulp Purée, etc.

Inquiries have been received concerning the labeling of canned tomatoes packed in their own juice, in added tomato juice, in whole tomato pulp or purée, or in pulp, purée, or seepage made from trimmings.

Properly ripened and prepared tomatoes packed in no more juice than normally comes from them after peeling and trimming may, without any qualification, be correctly labeled "canned tomatoes." This is the article which the purchaser expects to receive under the name "canned tomatoes," and is the only article entitled to that name without qualification.

Tomatoes packed with added tomato juice, with added whole tomato pulp or purée, or with added pulp, purée, or seepage from trimmings should be labeled with a plain and conspicuous statement of exactly what they are, to prevent the purchaser from receiving the erroneous impression that the article is canned tomatoes. The word or words, naming the added product should be printed in conjunction with the word "tomatoes." The term "standard tomatoes" does not inform the purchaser that the product is not canned tomatoes, and does not constitute a declaration of the added product.

Tomato juice is understood to be the juice which naturally drains from tomatoes after peeling and trimming them. This term is not properly applicable to finely divided pulp or purée made by cycloning trimmings or whole tomatoes or mixing of both. Seepage is understood to be the liquid which drains freely from trimmings without subjecting them to the vigorous rubbing of a cyclone or similar machine. In the preparation of pulp, purée, or seepage for canning with tomatoes particular care should be taken to eliminate all moldy, fermented, and other decomposed material.
Tomato Pulp

The extensive use of tomato pulp for the making of ketchup, sauce, soups, dressings for beans, fish, etc., has made its canning an important line both as a by-product of the regular canning factory and as a special line, the methods being essentially the same in both cases. The manufacture of pulp is advantageous to every tomato cannery for there is always a certain proportion of the tomatoes that cannot be peeled economically due to under or over size, irregular contour, cracks, green butts, etc. If these are not sorted out at the beginning, a large percentage is lost in the waste. If separated as a preliminary step and any unsound parts cut away, they can be made directly into pulp thus reducing the loss in material and cutting the cost of labor. The pulp from such tomatoes is the same grade as that from whole stock. It is not recommended that the waste from the peeling tables be conserved but if converted into pulp it must be labeled from “trimming stock.” The amount of pulp recovered from canning waste is small and particularly if one recognizes that a large part of the so-called juice is water carried on the surface of the tomato when it leaves the scalder. If tomatoes be not sorted as a preliminary step, then all the fruit not suitable for economical peeling becomes a part of the waste and with it the unfit portions which the peelers cannot or do not remove. Herein lies the just basis for the prejudice against any tomato product the label of which bears the legend “from trimmings.” By proper diversion of the material from the beginning and using appropriate means for its treatment, the tomato can be handled on either a small or large scale with little loss of sound material.

Pulping Equipment

The equipment necessary for pulping is simple but to date none has been especially designed for the small factory. One can handle 200 gallons or more per hour on the regular sorting table, washer, and scalder with a hotel pulper to separate the coarser fiber, seeds, etc. The standard equipment has a capacity of about 4,000 gallons per hour up to the evaporators. The evaporation needs to be done quickly and the simplest device for the purpose is the steam-jacketed kettle, which can be obtained in almost any size. The finishing may be done on a hotel pulper by changing the screens or on the small factory machines. In large plants a special equipment is needed consisting of a sorting table or belt, washer, preferably of the rotary type, scalder or breaking tank, pulper, evaporator, finisher, filler, and cooker. These will be taken up in detail under the several operations.

Sorting

A sorting table is a very important part of the equipment in the making of pulp, ketchup, or paste. It may be placed either before or after the washer. The advantage of placing it before the washer is that the work is done on dry fruit; if behind the washer, the fruit is clean, many cracks are cleaned by the spray so that they do not need trimming, and other defects are made more apparent. The disadvantage is that the fruit is wet and that the workers also become wet after a time.

The inspection table, or more properly belt, is generally two feet or more in width mounted so as to run at a convenient height for the sorters stationed on either side. The fruit needs to pass in a single layer and at a speed
APPERTIZING

no greater than can be followed by the eye without effort. The belt may be
made in short sections, to provide drops of about four inches, and these
cause the fruit to turn over and thus expose both sides. Another style of
conveyor is made of rollers which turn the fruit. Mention has already been
made of a simple device suggested by the Bureau of Chemistry.

One arrangement which has been used and strongly endorsed is the divi¬
sion of the belt into three sections by means of boards suspended from
above. The tomatoes are diverted into the two outer lanes and all the sound
ones are picked up and placed in the center lane by the sorters. This necessi¬
tates handling each fruit, which is the object sought. However, it seems
unnecessary to handle 90 per cent or more in order to separate 10 per cent
or less when the same object can be attained by taking out the objectionable
ones. Only in unusual cases of cracking or rotting should it be necessary
to handle each tomato.

A sorting belt needs to be at least 2 feet in width and 12 feet or more
in length to handle 5 tons of fruit per hour when the delivery is of prime
quality and this will be reduced to 3½ to 4 tons if there be much decay or
spotting. This provides space for five persons on either side if necessary.
Units of 3 feet in width and 18 feet in length are about the maximum for
the best work, and if greater capacity be needed it is better to add more
units rather than increase the size. The objection to increasing the length
of the belt is that the travel is too fast and the eye tires under the strain
after a time.

The number of persons working on a belt will depend upon the condition
of the tomatoes and the volume to he handled. If the tomatoes are good
the inspectors can use knives and trim defective fruit at once, but in the
event a considerable part require trimming, then the work must be limited
to sorting.

An important adjunct is the lighting. It should be clear and bright
whether natural or artificial and so located or directed that all defective
material can be detected at a glance.

Washing

The washer should be an efficient device as major dependence is placed
upon it for cleaning. The essential feature is the number of spray openings
so positioned as to play upon every part of the tomato and with a head
pressure sufficient to scrub every part of the surface. The rotary type is one
of the best and may be made of corrugated iron, perforated metal, or heavy
wire. The corrugated metal gives a positive rotation to the fruit so that
none can slide through. The cylinder is mounted on a gentle decline to aid
in carrying the tomatoes forward. If the water supply be abundant, the
fresh water pipe may extend the entire length of the cylinder, but if re¬
stricted, the first half or two-thirds of the cylinder may be served by a pipe
re-using some of the water and the balance of the cylinder should be sup¬
plied from the original source. The water which has been used is taken
up by a booster pump and delivered through the sprays under as much
pressure as desired. The water from the discharge end is constantly added
to the other to keep it clean. Another method to conserve water is to set the
receiving end of the cylinder in a tank and to elevate the delivery end.
Flights on the inside of the cylinder cause the tomatoes to be carried
through the sprays to the delivery end. The tank water is renewed from
the sprays. The rotation of the cylinder type of washer causes the tomatoes to rub against each other and thus loosen adherent dirt and in addition the spraying is generally of longer duration than on the belt type.

Rotary washers are usually from 12 to 16 feet in length and 2 feet in diameter, with a capacity between 5 and 6 tons per hour though sizes are built to handle as high as 12 tons per hour.

The type of washer in which the tomatoes are carried on a wire or open mesh belt under or between sprays of water may be made very efficient if sufficient sprays be used. The most obvious defect is that not enough sprays are used so that the fruit is subjected to the action but a few seconds. The tomatoes need to be turned over, or at least it is better that they be turned one or more times and this can be effected by cross sprays from below and oblique ones from the side. The amount of spraying and the force of the water need to be greater than for canning so that the same type of machine used in the cannery is likely to be deficient for tomatoes which are dirty from rain or have developed cracks. By cutting the belt speed, adding to the number of sprays, and using a booster pump to get the needed pressure, a distinct improvement can be made. A belt washer 2 feet wide and operating at 25 to 30 feet per minute has a capacity of about 5 tons per hour, and when increased to 3 feet in width, the capacity is practically doubled. Loading the belt with two or more layers of fruit nullifies effectiveness so that the opening needs to be equipped with a guard to prevent crowding beyond efficient capacity.

Tank washers are also available, varying from a simple boot with a short elevator conveyor having a few cross sprays, to elaborate apparatus with two or more compartments and with means for agitating the fruit while in the water, such as paddle-wheels, propeller wheels, air blast, and a system for thorough spraying as the tomatoes pass out. A modification in the procedure is the use of a pre-soaking tank in which the tomatoes are dumped and held for ten minutes or more and another in which wagon loads are dumped and may be held for several hours. The long soaking has the effect of checking mold growth and softens that which has taken place so that a smaller quantity will show in the microscopic examination. The claim is made that water storage prevents decomposition by arresting mold growth which normally takes place most rapidly in the air. The result is more apparent than real. Patches do become softened and slough off readily under sprays but bacterial changes occur which are more offensive in character than those which develop in normal storage.

Good washing requires a large volume of water and with a limited supply it is necessary to use it in such manner as to avoid waste. Pre-soaking for a short period as a minute to five minutes will loosen most adherent dirt so that a lesser amount will serve for spraying, and the waste from that operation can be used in the pre-soaker. Dividing the spray into sections has already been indicated as economical but most important is the use of small sprays at high pressure for it is the impact of the water upon the fruit which does the real cleaning, gets into the stem end and cracks and cuts out surface growth.

Sorting and washing have been emphasized for the reason that more tomato products have been seized as being “filthy, putrid, and decomposed” under the pure food law than any other canned product and a very large
part could have been prevented by better sorting and washing. Machinery manufacturers must share in the responsibility to the extent that their devices are defective or improperly rated in capacity.

Scalding

In the older method of preparing pulp the tomatoes were carried directly from the washer to large tanks where they were steamed until soft, which might be from 15 to 30 minutes or more, and the batch might stand for some time without injury. The pulp tissues were completely softened so that when run through a pulper the beater could be set well back, the pulp would be driven through the screen and the skin, seeds, and hard parts carried over as tailings without grinding through as pulp. The one objection is that the water of condensation from heating the tomatoes which amounts to approximately 125 pounds for each 1,000 pounds of tomatoes has to be boiled out, but to offset this the juice does not foam nearly so badly in the reducing kettles or tanks. One of the advantages is that there is little increase in organisms during any part of the subsequent operations.

The more common method at present is to convey the tomatoes through a continuous scalder to the pulper. In this case the skin is loosened so that it comes away easily but more of the core is ground up and becomes a part of the pulp. If the beaters be set back, the skins, cores, and green butts as well as pieces of corky cracks will be nearly all retained in the tailings. A combination of good sorting and washing with this method leaves little to be desired when quality is a first consideration. Temptation is to set the beaters close in order to get the maximum of pulp and thus force through material which should remain in the waste.

Tomatoes may be run directly from the washer into a combination crusher and pulper to separate the pulp, and this might seem to be the logical method if it were not for the fact that mechanical separation alone is not equal to that obtained by heat and friction. The crusher serves the purpose of putting the tomatoes in better condition for the pulper. By using close set metal beaters in the pulper a high yield can be obtained but some skin, core and hard parts are ground up and pass through the screen.

Pulping

The pulping apparatus is simple, the older type consisting of a cylindrical screen about 18 inches in diameter and 4 feet long, and with a shaft and beaters inside to force the pulpy portion of the tomato through and carry the hard parts as skin, seeds, and core over the end. The screen was originally made of stiff brass wire, ten meshes to the inch. The beaters were adjustable with reference to the space between the paddle and the screen, permitting close setting for thoroughly ripe or well steamed fruit and farther back for that which was greenish. The speed was usually about 400 revolutions per minute which developed centrifugal force and friction to make the separation. The capacity was about 250 bushels or 1,700 gallons per hour.

In the newer type a perforated metal cylinder takes the place of the wire screen, the perforations being seven one-hundredths of an inch or other diameter selected. The screen is perforated only on the lower half or slightly more since more than 80 per cent of the separation occurs in that area and that driven through the top does not run off promptly and may become
objectionable. The beater consists of a shaft with three or four metal bars which can be set as close to or as far from the screen as is warranted. Stainless steel, monel metal, and brass are used in all parts with which the tomatoes come in contact so as to avoid contamination from iron. A breaker may be built into the receiving end to increase the capacity, which is from 250 to 350 bushels per hour.

In order to avoid whipping the air into the pulp and the attendant oxidizing effect, a small steam pipe may lead into the receiving end with sufficient discharge to keep the air saturated.

Neither the raw juice from the cyclone nor the concentrated pulp from the cookers should be permitted to come in contact with iron but be conducted from one point to another in glass-lined or stainless steel pipes. The tannins of the fruit in contact with iron give a dark color and an astringent flavor. Stainless steel, copper heavily tinned, or glass-lined pipe should be used and then in the shortest lengths that are practical.

As far as has been learned, no experiments on a factory scale have been reported to determine the comparative advantages of the three methods of pulping; that is, yield per ton, quality of the pulp, and cost of production.

**Evaporation**

Evaporation may be carried out in jacketed kettles, in tanks with coils, or in a vacuum pan. The choice depends in a large measure upon the volume to be handled. For small plants the jacketed kettle is the simplest and the most convenient to use and the least expensive to install. The size of the kettle should be at least one-third greater than the batch which it is desired to use and preferably of a rather deep type so as to have the minimum trouble from foaming. A good kettle having a steam supply at 80 pounds pressure or above evaporates juice to practically half its volume or to the consistence of standard pulp in from 30 to 35 minutes.

The flash coil is particularly well suited to large batches, or from 300 to 1,000 gallons capacity and is fitted in glass-lined or wooden tanks. The coil needs to be designed with reference to the tank to get the best results. A liberal steam supply at about 100 pounds pressure is needed and the condensate controlled by means of steam traps. These reduce juice to standard pulp in less than 30 minutes. Too much emphasis cannot be placed upon the need of high pressure in the steam line for it is the high heat that causes the rapid circulation of the juice and keeps the coils bright and clean. A coil that is not hot will bake the juice upon the surface and in a few minutes cease to give up heat. Hand cleaning is then necessary which is a hot and unpleasant job. A propeller circulator is often placed in tanks with coils, and sometimes in kettles and assists materially in keeping the heating surface clean.

The vacuum pan is a special mechanism to obtain evaporation at reduced pressure and therefore at low temperature. It is more complicated than the jacketed kettle or coil, the first cost is higher, and some training is needed to handle it, three reasons why they are not common, though there has been an increase in the number used during the past ten years. The cost for reducing juice to standard pulp is not materially lessened over that by the kettle or coil, but is for paste. The quality is much better, especially in the heavy concentrations.
When the heat is first turned on the raw juice in an open cooker it foams, sometimes very badly and more from some varieties of tomatoes than from others. This can be controlled by a blast of air directed upon it. Probably the most common method is to add a small quantity of vegetable oil. In order to avoid foaming in a vacuum kettle, it is customary to first bring the pulp to near a boil in an open kettle or tank and hold it from three to four minutes.

**Relation of Time of Cooking to Color**

A small number of experiments were made by MacGillivray to get the effect of time of cooking on changes in color. Short cooks varied from 32 to 48 minutes, and long cooks varied from 71 to 125 minutes. He reports that 80 per cent of the color changes occur in the first few minutes of cooking and that after that the changes are not appreciable to the eye, so that a long or short cook would not seem to be a factor. The results are rather surprising in the light of practical experience and when one sees bright colored ketchup put up with all the speed possible and the dull, muddy sort which comes with huge batches and prolonged heating.

**Cooking to a Desired Consistency**

The raw tomato juice is evaporated to the desired consistence on the basis of the specific gravity, but this does not properly evaluate a pulp, for two pulps of the same specific gravity may be quite different for manufacturing purposes. However, it is the best test now available and provides a good basis for pulps made in the same manner.

The older method was to use a batch stick, marked to a certain number of gallons in the kettle, fill the juice to the mark, and to have another mark at the point where the batch was to be finished. For greater convenience the juice was heated to 200°, which was about as high as possible and have the mass quiet and then fasten a cross-arm to indicate the level and the operation repeated for the finish mark. This made reading easy and by following the same technique on each kettle it gave a close approximation to uniform batches. The time required to determine either level is very short, only from 15 to 20 seconds to quiet the mass by turning off the steam. Adjustments are made on the stick as the season advances and the tomatoes become more watery. The results are close enough for practical purposes and re-use by the same company but would need to be checked by more nearly exact methods if placed on the market. The cook also learns to time the batches and thus aid in testing. Cooking to a consistence as determined by the break in pouring from a dipper is unreliable though it may be indicative to the cook that evaporation is nearing the proper stage.

**Specific Gravity**

The standardizing of pulps began to be agitated about 1910, as it was found that manufacturers' samples which were evaporated as nearly one-half as they could determine in their factory operations averaged about 1.035 on the specific gravity scale. This was considered best for ketchup manufacture. For household use a specific gravity of 1.040 more nearly meets the varied requirements. Such a determination required the assistance of a chemist as no factory method could be applied to hot pulp by the cook. The regulation hydrometer does not work in a mixture of solids and liquid, and there is not time for filtering and cooling when cooking a batch.
The closest approach was to use hydrometers with a short scale, such as can be obtained in sets, draw about a pint of pulp, filter through cotton cloth or porous paper to obtain a three or four ounce sample and cool in an aluminum container. This requires but a few minutes and is more nearly accurate than the batch method.

The writer attempted a direct weighing method and had flasks made with short necks cut off at the 500 cubic centimeter mark at 200° F. These were held in a wire frame, dipped into the hot batch, then into a bucket of hot water to clean the outside, and weighed. Tare weights were made for each flask so that getting the weight with only the minimum of time was easy, but breakage and the fact that pulp made in 30 minutes and that made in two hours, limits which were common at that time, although of the same specific gravity, were very different for manufacturing purpose, led to the belief that the method did not meet all the requirements for the cook room and it was abandoned. A special Chatillon scale was used so that the zero point on the dial could be moved to the tare point and the final reading be the actual weight. The scheme was given to David Lowe who improved it by making a copper flask to hold one liter of hot pulp but filled with a funnel and dipper and weighed on an even balance scale. This was the most used apparatus up to 1930. In 1926, a new apparatus was developed by Thomas W. Manns, University of Delaware, Newark, which is also a direct reading type, based upon weight, embodying features that insure a greater degree of accuracy and permit rapid sampling.

An apparatus used by large manufacturers, known as the refractometer, is based upon the fact that a beam of light when passing through a body is deflected from a straight line and the deflection is proportional to the density of the body. It is a method in common use among chemists for testing sugar solutions, etc. The apparatus is rather expensive but its operation is so simple that a person can be trained to handle it in a very short time. In one type only a few drops of filtered pulp is required and the entire sampling can be done within a minute. Tables have been worked out by the National Canners Association Laboratory to convert the readings on the dipping style of instrument to specific gravity and by Huelsen for the Abbe type.

Still another method has been developed by R. V. Strasburger, Baltimore, Maryland, based upon the principle of making solvents which are miscible between themselves, are clear, of the specific gravity desired, but immiscible with pulp so that if the latter be added and is light, it floats, if heavy, it sinks to the bottom, and if of the same specific gravity it remains suspended.

The two agents selected are carbon tetrachloride and varnolene. The former is used commonly as a fire extinguisher and the latter is a petroleum product. Other substances were tried but none found equally satisfactory. One of the minor objections to the combination selected is the tendency of the mixture to change specific gravity, but this can be overcome by using care in the preparation and handling. The following paragraphs give the essential details.

---

"To prepare the solution, a quantity of Varnolene having a specific gravity of 0.7782 is poured into a graduate or other suitable receptacle, and Carbon Tetrachloride of 1.5853 gravity added until a hydrometer immersed in the solution indicates the required gravity. The Carbon Tetrachloride should always be added to the Varnolene, as the heavier liquid will diffuse through the lighter one; whereas, should conditions be reversed, the Varnolene, being lighter, would tend to float on top and not mix. At all events it is always advisable to aid diffusion by shaking or stirring. The solution should be stored in a well-filled, tightly-stoppered bottle, as on exposure to air it changes gravity fairly rapidly. A solution whose original gravity was 1.035, when exposed to the air for a single day at room temperature of 75° F., fell to 1.027—a loss of 0.008. Several liters of the solution may be made up at a time and stored as described. Any slight variation may be adjusted before using. For control work the solution is used in test tubes about 1 inch by 8 inches, well filled and tightly corked, sufficient tubes for the day's run being made up on the previous evening. The tubes are placed in a handy rack in the pulp room along with a long-armed dipper, a small tin cup, a supply of ½-inch bore glass tubing in 8-inch lengths, and a bucket of cold water. When the cook deems the pulp ready for testing, a dipperful of the boiling pulp is removed and a small portion poured in the tin cup and cooled in the water. One drop of the chilled pulp is dropped into one of the tubes of test solution; if it is undercooked, the drop will float; if sufficiently cooked, it will balance in the solution; if overcooked, it will sink. In practice the pulp is cooked until it just sinks to the bottom of the tube. A tube of solution may be used until the pulp contained interferes with the trial. Cooling of the pulp is necessary, since the heat of the boiling temperature would cause a great change in the gravity of the solution.

"The used solution may be reclaimed by first settling out the pulp in a large receptacle, then filtering several times through cotton, and finally through filter paper. The solution will necessarily have to be readjusted before using. The limit of reclamation is the depth of the yellow color that the pulp finally imparts to the solution. After the solution has been used and adjusted three times, it is cheaper and more satisfactory to discard it and start anew.

"The method offers both speed and ease of operation, with a minimum of responsibility upon the cook. The accuracy of results is more than comparable with those that are obtained by other methods. The cost of the materials is almost negligible, at less than one cent per batch. Besides, this same method may be used in cooking catsup or chili sauce to a definite specific gravity. Finally, it may be advantageously used by the buyer of pulp, as a large number of samples may be tested in a very short time."

Little use has been made of this method.

The National Canners Association has published two bulletins* upon tomato products, pulp, ketchup and chili sauce which go into detail upon the methods used in testing and especially to make clear the importance of knowing the relation of the raw material to the finished product as shown by the specific gravity. An abridgement of the table on equivalent values is as follows:

Equivalent Values of Pulp of Different Degrees of Concentration

The table shows the number of gallons of pulp at a specific gravity of 1.035 equivalent to 1,000 gallons of pulp of the specific gravity shown in the first column.

<table>
<thead>
<tr>
<th>Specific Gravity at 68° F.</th>
<th>Per cent Solids</th>
<th>Equivalent Gallons at 1.035</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.035</td>
<td>8.37</td>
<td>1000</td>
</tr>
<tr>
<td>1.036</td>
<td>8.62</td>
<td>1031</td>
</tr>
<tr>
<td>1.037</td>
<td>8.86</td>
<td>1061</td>
</tr>
<tr>
<td>1.038</td>
<td>9.10</td>
<td>1091</td>
</tr>
<tr>
<td>1.039</td>
<td>9.35</td>
<td>1122</td>
</tr>
<tr>
<td>1.040</td>
<td>9.60</td>
<td>1153</td>
</tr>
<tr>
<td>1.041</td>
<td>9.88</td>
<td>1184</td>
</tr>
<tr>
<td>1.042</td>
<td>10.10</td>
<td>1215</td>
</tr>
<tr>
<td>1.043</td>
<td>10.35</td>
<td>1246</td>
</tr>
<tr>
<td>1.044</td>
<td>10.60</td>
<td>1277</td>
</tr>
<tr>
<td>1.045</td>
<td>10.84</td>
<td>1308</td>
</tr>
<tr>
<td>1.046</td>
<td>11.08</td>
<td>1338</td>
</tr>
<tr>
<td>1.047</td>
<td>11.33</td>
<td>1369</td>
</tr>
<tr>
<td>1.048</td>
<td>11.57</td>
<td>1400</td>
</tr>
<tr>
<td>1.049</td>
<td>11.82</td>
<td>1432</td>
</tr>
<tr>
<td>1.050</td>
<td>12.07</td>
<td>1464</td>
</tr>
<tr>
<td>1.051</td>
<td>12.32</td>
<td>1495</td>
</tr>
<tr>
<td>1.052</td>
<td>12.57</td>
<td>1526</td>
</tr>
<tr>
<td>1.053</td>
<td>12.81</td>
<td>1557</td>
</tr>
<tr>
<td>1.054</td>
<td>13.05</td>
<td>1588</td>
</tr>
<tr>
<td>1.055</td>
<td>13.30</td>
<td>1620</td>
</tr>
</tbody>
</table>

In other words, each one-thousandth increase in weight or specific gravity of finished pulp requires an increase of one-fourth of one per cent in solids and is equivalent to 31 gallons of pulp of a specific gravity of 1.035 for each thousand produced. One thousand gallons of pulp at 1.055 is equivalent to 1620 gallons at 1.035.

The pulp may or may not be “finished” as soon as the cooking is completed depending upon the use that is to be made of it. If intended for soup it is finished, that is, run through a machine similar to the pulper but about one-half the size, with a much finer screen, with the beater set close to the screen and running at a much higher speed, about 700 to 750 revolutions per minute. Formerly brushes were used as beaters but have been superseded by plain metal as being much cleaner. Coarse fiber and particles which pass through the pulper are removed and the pulp given a very smooth appearance. A finisher has practically the same capacity as a pulper. If the pulp is for ketchup, the finishing may or may not be done, as most manufacturers prefer to finish after the ketchup is made so as to remove any bits of onion, garlic, or particles of spice as well as the rough tomato. A few finish immediately after pulping or before evaporating so that filling of the cans can be made directly from the cooking kettle without a lowering of temperature due to an intermediate operation. The aim is to get the pulp into the cans at about 190° F. and depend on that to sterilize the cans and especially if five gallon cans be used. The hot cans are allowed to stand from 20 to 30 minutes and then cooled. If the pulp be finished after the concentration, it is run into a jacketed tank to hold the temperature at near 180° F. while the cans are being filled. Sealing at such high temperatures causes a marked collapse of the cans so that others prefer to let the temperature drop to about 160°, seal, run through a continuous cooker for 10 minutes, and follow by cooling, and especially for No. 10 cans. This is
without question the safest way. The 5-gallon can increases the hazards of loss but serves a good purpose when used for storage at the place where final manufacture takes place.

Pulp is also made of higher specific gravities for use in pork and beans, fish sauce, and for other purposes, thus effecting a considerable reduction in the number of containers and storage space for each thousand gallons packed. The value, however, is based upon the standard specific gravity, 1.035.

Pulp is packed in No. 1 cans for household use as in the making of soup or for addition in the preparation of other dishes. Combinations with crushed peppers as chillies or pimientos are also made and used in the same way. These latter are sometimes designated as hot sauces.

The latest addition to products of this class is tomato juice, used for beverage purposes and especially to supply vitamins. The tomatoes are pulped and finished and the juice packed without concentration. That will be treated in more detail under its own heading.

The earlier method of preparing pulp has only a historic interest. The tomatoes were steamed in a tank, run through a pulper, and the pulp allowed to stand in a tank from two to four hours, during which time the fibrous portion separated by gravity, rising to the top. The clear portion was drawn off from the bottom and usually discarded. In some cases the pulp was delivered into tall bags and allowed to filter to save time in this separation. Since the clear or watery part contains the normal acids and other soluble solids of the tomato, the part which has the maximum of flavor and practically the same composition as the whole pulp, that method of treatment resulted in much waste. The fibrous portion was heated and might be given further evaporation. It was packed in barrels, jugs, and cans and naturally was frequently accompanied by fermentation. In some cases the pulp was purposely held to ferment, the normal lactic fermentation of the tomato being considered better or more agreeable than that which comes from adding vinegar.

**Label Weights**

Pulp, 8.37 per cent solids (Sp. Gr. 1.035). 6Z, 5¾ ozs.; 8Z Short, 7½ ozs.; 8Z Tall, 8¼ ozs.; Picnic—No. 1 East, 10¼ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 3 ozs.; No. 2½, 1 lb. 12 ozs.; No. 3, 2 lbs. 1 oz.; No. 5, 3 lbs. 8 ozs.; No. 10, 6 lbs. 8 ozs.

Purée, 12 per cent solids (Sp. Gr. 1.05). 6Z, 5¾ ozs.; No. 300, 14½ ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2 Special, 1 lb. 3 ozs.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 9 ozs.

**UNITED STATES STANDARDS FOR GRADES* OF CANNED TOMATO PULP**

January 25, 1934

**Definition**

Canned tomato pulp is the product resulting from the concentration of the screened or strained fleshy and liquid portions of ripe tomatoes, except those portions from skin and core trimmings, with or without the addition of salt. The product contains not less than 8.37 per cent of tomato solids (specific gravity 1.035), is packed in her-

*These standards for grades are so framed as to exclude substances not mentioned and in each instance imply that the product is clean and sound.
metically sealed containers, and sterilized by heat. When examined according to the Howard method, mold may show in not to exceed 50 per cent of the microscopic fields; bacteria not in excess of one hundred million per cubic centimeter, and yeast and spores not in excess of 125 per 1/60 cubic millimeter.

GRADES OF CANNED TOMATO PULP

U. S. Grade A (Fancy) canned tomato pulp consists of tomato pulp of good, red, ripe tomato color; is practically free from particles of seeds, specks, skins, cores, and other defects; possesses a good typical tomato pulp flavor, and scores not less than 85 points when scored according to the scoring system outlined herein.

U. S. Grade C (Standard) canned tomato pulp possesses a fairly good color in which red predominates; is reasonably free from particles of seeds, specks, skins, cores, and other defects; has a fairly good tomato pulp flavor, and scores not less than 70 points, nor more than 84 points when scored according to the scoring system outlined herein.

Off-Grade (Substandard) canned tomato pulp is pulp which fails to comply with the requirements of the foregoing grades, but within the legal requirements for mold, yeast and bacteria, or scores below 70 points when scored according to the scoring system outlined herein, or, when any one of the grading factors falls in subdivision D. Tomato pulp having mold, yeast, bacteria, or spores in excess of the limits specified in the definition will be certified as "Illegal," when certificated under the Farm Products Inspection Law, or United States Warehouse Act.

Amplification of Grade Designations

When certificates of grade are issued under the Farm Products Inspection Law, or the United States Warehouse Act of August 11, 1916, as amended, the quality designation shall, in addition to the grade, show the specific gravity.

For example, a certificate of grade would indicate:

U. S. Grade A—Specific Gravity 1.044.

PREREQUISITES TO GRADING

Condition of Container

Containers shall be sound and clean. If the containers are metal, they shall be free from rust and serious dents and the ends shall be flat or concave.

Condition of Package and Label

If cased, the canned tomato pulp shall be packed in clean, neat, unbroken packages. If labeled, the labels on the container and package shall be clean and shall be neatly and securely affixed, and shall comply in all respects with the requirements of the Food and Drugs Act.

Fill of Container

Cans of tomato pulp shall be filled as full as is consistent with the maintenance of quality.

Cans of tomato pulp will be considered as of standard fill if the head space, measured from the top of the product to the underside of the lid, does not exceed 10 per cent of the total inside height of the container.

A certificate of grade covering canned tomato pulp that does not meet the above requirements shall bear the legend,

"Below U. S. Standard"
"Slack Fill"

Certificates of grade issued under the Farm Products Inspection Law, or the United States Warehouse Act, will indicate the net weight of the product.

ASCERTAINING THE GRADE

The grade of canned tomato pulp may be ascertained by considering, in addition to the foregoing requirements, the following factors: Color, Absence of Defects, and Flavor. The relative importance of each factor has been expressed numerically on a scale of 100. The maximum number of credits that may be given for each factor is:

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Color ................................................. 50</td>
</tr>
<tr>
<td>II. Absence of Defects ................................ 20</td>
</tr>
<tr>
<td>III. Flavor ............................................... 30</td>
</tr>
</tbody>
</table>

Total ................................................... 100
Ascertaining the Rating of Each Factor

The essential variations within each factor are so described that the value may be ascertained for each factor and expressed numerically. The numerical ranges within each factor are inclusive. For instance, the range 13 to 15 means 13, 14, and 15.

I. Color.

(A) Tomato pulp that is of good, red, ripe tomato color may receive a credit of 43 to 50 points. (A score of 43 points or more will be credited pulp having color equal or better than that produced by spinning a combination of the following: Munsell color discs: R65 (5R 2.6/13) - (Glossy finish); YR21 (2.5YR 5/12) - (glossy finish); N1 (glossy finish); N4 (mat finish).

(C) If the tomato pulp possesses a fairly good color with red predominating, a credit of 35 to 42 points may be given. Tomato pulp that falls in this classification shall not be graded above U. S. Grade C (Standard), regardless of the total score for the product. (To score 35 points or over, a color must be equal to or better than that produced by spinning a combination of the following Munsell color discs: R45 (5R 2.6/13) - (glossy finish); YR28 (2.5YR 5/12) - (glossy finish); N1 (glossy finish); N4 (mat finish).

(D) When the color of tomato pulp is poor, being reddish brown, or ranges in the orange to yellow group of colors, a credit within the range of 0 to 34 points may be given.

II. Absence of Defects.—Under this factor, workmanship is considered, including the presence of particles of seeds, specks, skins, or cores.

(A) When the product is practically free from such defects, a credit of 16 to 20 points may be given.

(C) If defects are present, but not noticeably prominent, a credit of 13 to 15 points may be allowed. Tomato pulp that falls in this classification shall not be graded above U. S. Grade C (Standard), regardless of the total score for the product.

(D) Tomato pulp in which the defects are prominent may receive a credit within the range of 0 to 12 points.

III. Flavor.—This factor refers to the palatability of the tomato pulp.

(A) If the product possesses a clean, typical, well developed tomato pulp flavor, a credit of 26 to 30 points may be given.

(C) When the product possesses an acceptable tomato pulp flavor, a credit of 21 to 25 points may be allowed. Tomato pulp that falls in this classification shall not be graded above U. S. Grade C (Standard), regardless of the total score for the product.

(D) Tomato pulp that possesses a foreign or “off” flavor, being either sour, scorched, or bitter, may not receive above 20 points in the score.

Tomato Paste

Tomato paste differs from tomato pulp in the degree to which the concentration is carried. The body varies in consistence from that which flows easily out of a can to a density that a spoon or knife is necessary to take it up. The style of preparation was developed by the Italians who manufacture more than is done in other countries.

The preliminary steps in manufacture are the same as for making pulp or they may be modified in that the tomatoes are run through a chopper or grinder after the sorting and washing, then heated in a jacketed kettle at boiling until they cease foaming, and are then run through the pulper. This gives more fiber in the pulp, which is desired in that product. Instead of using the open cooker for concentrating, the work is done in a vacuum pan, the preliminary boiling serving a useful purpose in the sterilization.
Reducing under a low pressure hastens the operation and above all contributes to quality owing to the lower temperature used. The boiling is done at about 22 inches of vacuum or about 140° F. When the batch is reduced to approximately the proper volume, a sample is drawn and tested by the refractometer method. This can be done quickly and as the operator learns from experience the rate at which concentration takes place, it is possible to make the consistence nearly constant in successive batches.

Paste made in open kettles is almost certain to have a very dull red or brownish color, to be moist, and to have a sharp and somewhat bitter, burned taste. When the product becomes fairly heavy, it is difficult to keep it circulating so as to prevent sticking to the kettle or coils. A stirring device helps to prevent this condition.

A scheme sometimes used to avoid excessive cooking of the more cellular or fibrous portion, especially when using open cookers, is to filter the juice and evaporate the clear portion to almost a sirup and return it to the solids for the final cooking.

The acidity increases at very nearly the same rate as the reduction in volume of the pulp, therefore, paste of high concentration becomes very acid. Some makers neutralize a part of the acid in order to improve the flavor and also the color. This is done by adding bicarbonate of soda to the pulp after it has boiled, the reason for this being that boiling while in an acid state aids in sterilization. Eight ounces of bicarbonate of soda will neutralize the equivalent of one-tenth of 1 per cent of acidity in 100 gallons of pulp. The amount of soda used will be determined by the original acidity of the tomatoes and the degree of neutralization desired.

No standards have been agreed upon for tomato paste, the solids ranging from 25 to 40 per cent, the price being based upon the per cent present. Reliance is placed upon the high concentration for keeping.

The paste pack in 1929 amounted to 606,140 cases of which almost one-half was packed in California.

**Label Weights**

(Sp. Gr. 1.09). 5Z, 4¾ ozs. 6Z, 6 ozs.


**Tomato Ketchup**

Ketchup is a spiced sauce used for its condimental effect in imparting flavor or relish to other foods. It receives its distinctive name from the base used as tomatoes, mushrooms, walnut, grape, currant, etc.

The forerunner of this sauce was an Oriental product which was highly esteemed and brought to England, so far as known, the latter part of the seventeenth century. There it was imitated by using mushrooms, or green walnuts as the base, and later fruits, then the tomato. Tomato ketchup was the outstanding American sauce, leading all others in commercial manufacture but recently dropped as second to mayonnaise. It began to assume a commercial importance about 1890, but had been made in the home and for use in local trade for many years prior. According to the Bureau of Commerce, the pack in 1925 was valued at $27,801,386, Indiana leading with an output valued at $6,150,994.
The Name

The terms ketchup, catchup, and catsup are used indiscriminately for this spiced sauce, the one chosen seemingly being a matter of personal preference on the part of the maker and singularly this mixed terminology has existed ever since the sauce became common in England. If the term be based upon a historical background, then the preference would be undoubtedly for ketchup as that was the closest spelling the English could give to the pronunciation of the name of the Oriental sauce. Catchup apparently came into use as an attempt to use a proper form for ketch, assuming this to be a colloquial expression. Catsup and dogsup were used in a sort of derogatory sense, the latter name being dropped in a short time.

The English now use the term chutney for the same kind of sauce and American ketchup sent to England fares better in the market if it bear that name on the label.

From the earliest history of this sauce it represented skill in making a well balanced spiced sauce without making it unduly hot with peppers or permitting any one ingredient to dominate the whole. It might be thin as is usually the case with walnut ketchup, or be so thick and heavy that it will scarcely pour from the bottle as seen in some of the tomato ketchups. It might be made with fermentation, as was usually the case until twenty-five years ago, or without fermentation, the acidity in the former being in part due to the fermentation and in the latter to added vinegar. In fermented ketchup the acidity is largely lactic, which is more agreeable to many persons than the sharp acetic of vinegar. Fermentation was considered a normal process as much so as in the making of sauerkraut, pickles, wine, vinegar, or cheese. The same practices continued in this country until about 1912 when the fermentation process was stopped because of the abuses which had developed through the use of improper material. The use of a chemical preservative, especially benzoate of soda, was also common and a change to the nonpreservative type; that is, in which vinegar and sugar in sufficient quantities plus sterilization by heat act as the preservative agents, occurred at practically the same time. The earliest manufacture of commercial nonpreservative ketchup in this country seems to have been made by E. C. Hazard of Shrewsbury, New Jersey. Under the present federal regulations, any ketchup made by the fermentation process would necessarily be considered as composed in whole or in part of "filthy, putrid, and decomposed" material.

Manufacture

The best tomato ketchup is made directly from clean, sound, fresh, ripe tomatoes with the addition of salt, sugar, vinegar, onions, garlic, and spices, the work being done rapidly and at one operation, with the shortest heating consistent with sterilization. This admits of better control of flavor and color and a more pleasing consistence than when the work is done in two stages as when the manufacture is from canned pulp. It effects an economy in heat, labor, and material. Ketchup made from fresh stock varies more in composition than from pulp stock, but this is of much less importance than is fine appearance and good flavor, qualities more needed in a condiment than that the specific gravity should not vary more than two points in the third decimal place. It is better for ketchup that the cook be a chef in his line than a robot in compounding.
The preliminary steps in the making of ketchup up to the delivery of the
cyclone juice into the cooker are the same as for pulp. The batch is mea-
sured so that there will be a standard to which to add the flavoring ingredi-
ents. The steam is turned on and as soon as the foaming ceases the spices
are added.

**Spicing**

The spicing is an essential part of ketchup with the amount and variety
of the ingredients used determined by the flavor wanted. Unfortunately
this is often determined by a purchased formula in imitation of some popu-
lar brand. Some ketchups are spiced mildly in order to retain the tomato
base flavor, to accentuate it rather than completely mask it; others are
spiced with such a liberal hand that the base might as well be any thickener
to carry spices and the result be the same. With the use of a high sugar and
vinegar content to insure keeping quality without sterilizing, the spice con-
tent has been generally increased over that of twenty years ago. There is
more uniformity in ketchups and while the average is better, not all agree
that they are as pleasing in flavor as were some of the milder types.

Cinnamon, cassia, cloves, allspice, mace, pepper, cayenne, paprika, fresh
peppers, bay leaves, caraway, celery seed, ginger, mustard, and other condi-
ments are found in the various recipes. The spices may be used whole,
ground, or in the form of acetic or oil extracts. The best flavor is obtained
by using broken whole spice, which is the most expensive form for the
reason that only a partial extraction of the flavoring material is made in
the short time in which the cooking is done. The spices are weighed for
each batch and all those used except cayenne and paprika are put in a cloth
bag or wire cage and put into the batch. The cloth should not be too heavy
or of too fine mesh or it will interfere with the extraction. The spices should
cook during the entire period in order to get as much as possible out of
them. H. E. Bishop, of the Indiana State Board of Health Laboratory,
found that where boiling was kept up for thirty minutes, only 27.8 per cent
of the oil of cassia, 11.5 per cent of the oil of cloves, and 33.3 per cent of
the oil of allspice were extracted. One of the objections to the use of whole
spice is that some of them, notably black pepper and allspice release dark
colored matter. Cloves offend in the same way so that some manufacturers
prefer to use part oil extract. The bags cannot be placed in succeeding
batches in order to get better extraction and have the same flavor, as that
which comes from the second and third cooking is less pleasing. A few
packers use an excess of spice and allow the bag to cook for only 12 to 15
minutes. Ground spice is little used as it appears in small specks in the
finished product. At one time it was used in cheap commercial grades and
home productions.

The grade of spice also has an effect, the cheaper stock not only being
weak in desirable flavor but in addition it releases more color so there is no
economy in its use.

Small quantities of cayenne are frequently used to take the place of
black pepper but unless judiciously used the tendency is to make the sauce
hot and burning instead of mildly warm.

Acetic acid extracts have gained greatly in use, especially since the sugar
and vinegar content has been raised, but they add a peculiar harshness that
differs from whole spices. A modification along this line and which gives
a nearly complete extraction of the flavoring principles is to soak the whole spices in the vinegar for three or four weeks before the manufacturing season opens and then use the vinegar. The spice is weighed in the proper proportions so that a given quantity will season a batch.

Oil extracts are much more aromatic than the acetic. A small quantity imparts much flavor but there is something suggestive of the drug store about them.

Paprika rosen, Hungarian, or sweet paprika is used primarily for coloring, though it is classed as a spice. It is a mild variety of Capsicum annuum, having a more intense red color and less pungency than the ordinary red peppers. It can be obtained as the bright fruit, ground dry, or in oil. In the last case, it is said that part of the capsicum is removed, also that the oil sets the color. The oil is of a reddish yellow color and the large number of globules and irregular masses serve to distinguish it from cayenne pepper. It requires so much more than ordinary paprika to get flavoring that no manufacturer could afford to use it for this purpose. It will conceal inferiority to some extent in that it imparts a bright color where otherwise a muddy color might be present. The color is not enduring and is easily recognized under the microscope.

Onions and garlic are added in varying quantities but not in amounts to be readily recognized. They are chopped very fine and may be placed in the same bag with the spices or in another and cooked for a short period, as twenty minutes. A considerable modification of flavor is obtained by the length of time of cooking.

Vinegar is added to all unfermented ketchup and a small amount was generally added to the fermented. Most manufacturers prefer to use ten per cent distilled grain vinegar as a lesser volume will produce the required acidity and with less interference with concentration. Cider and malt vinegars may be used but are not economical. The vinegar is not added until the batch is nearly finished, as adding it earlier results in driving off a considerable portion of the volatile acidity. Experiments made by adding vinegar to pulp and evaporating to fifty per cent of its weight in 20 and 40 minutes respectively show that in the former case the added acidity was decreased in almost the same proportion as the total evaporation, but in the latter case the acid was not driven off quite so rapidly as the moisture. In order to obtain the sterilizing effect of boiling in an acid medium, it is advisable to make the addition at least five minutes before the end of the cooking period. The vinegar and sugar may be heated together in a separate small kettle so that the addition to the batch will not check the boiling more than momentarily. The amount of vinegar added is generally such that the total acidity produced is in excess of 1.25 per cent. Heating the vinegar and sugar together insures sterilization should any heat resistant organisms be present in the latter.

Citric acid is sometimes used in place of vinegar but as the flavor is different and its preservative effect not so pronounced, it offers no advantage and has an increased cost.

Sugar is added to give flavor and to neutralize the sharpness induced by the vinegar when that is used as a preservative. The higher the acidity, the greater the quantity of sugar needed. In the higher grades of ketchup granulated sugar is used. If soft sugar or corn sugar be used, it should be
for the purpose of getting a slight modification of flavor rather than any economy. The amount of sugar added is generally above 12 per cent of the completed batch.

Salt is used sparingly and may be added at any time but preferably near the close of the cooking.

The use of flour or starch in any quantity for the purpose of making the body thick or heavy is properly regarded as an adulteration and the same applies to a foreign pulp as pumpkin or apples.

The finishing point for a batch of ketchup is ordinarily left to the judgment of the cook and especially for that made from fresh stock. In this he may be aided by the use of the batch stick, weighing tests, or refractometer tests in the same manner as for pulp though using different specific gravities. In working with stored pulp, the batch tests are more generally followed. The yield from fresh stock is from 4 to 6 per cent greater than from canned stock to get the same general effect, due to the pectinous materials which combine with the acid and sugar to give a weak jelly-like quality and which is absent in the canned stock. The same thing holds for pulps cooked quickly, that is, those cooked in less than thirty minutes as compared with others requiring an hour or more to make the reduction. In those cooked slowly there is more separation of liquid from the solids, thus giving the appearance of being thin.

A ketchup having a specific gravity of 1.090 is apt to be thin; a satisfactory consistence is more often obtained at about 1.120 to 1.140.

**Finishing**

As soon as the batch is cooked, it is run through the finishing machine to remove any hard pieces of tomato, bits of spice, or other material which may have been added and to give a smoothness of body by breaking it into small particles. There are two types of finishers: the vibrating screen and cylindrical screen with rubbing brush. The former is suitable for thin ketchup, and the resultant product gives the best possible appearance under the microscope. The tissues show whole cells, little tearing, and the minimum amount of debris and mold filaments. The objections to the sieve are that the capacity is small and the waste is relatively large. The rubbing finisher, previously described in the preparation of pulp, needs to be carefully adjusted, otherwise it forces practically everything through in a very finely comminuted state. The cells of the tissues are torn to shreds, their contents discharged, molds are broken into hundreds of fragments, and a ketchup may be made to have the appearance of being made from poor material.

The ketchup is delivered from the finishing machine into a storage tank where the temperature can be maintained at about 165° to 170° F., the heating being done by coils or jacket and a gentle agitation kept up.

**Bottling**

Clean bottles are used for the packing of ketchup and with the use of the modern filling and closing machines it is not necessary to touch them by hand so they can be filled as hot as desired. A temperature of about 165° F. is about the upper limit, as to pack at a higher temperature allows too much space in the neck upon cooling but more important than this is that the danger of accidental burns is reduced. If a low temperature be used, the
time for pasteurizing is increased since ketchup is a very poor conductor of heat and the heavier the body, the longer the time needed. A pasteurization at 190° for 35 minutes for pints or less, 45 minutes for quarts, and an hour for gallons will be found sufficient if the bottling be done at about 160° and the bottles be passed into the pasteurizer at once. By turning the bottles on the side the time can be shortened from 20 to 25 per cent and, furthermore, the contact of the hot ketchup with the seal not only reduces the chance of infection from that source but aids in making a tighter closure and less discoloration in the neck of the bottle.

The majority of manufacturers no longer pasteurize but depend upon the high acidity and heavy body to give them the necessary protection. This is the easy procedure from the manufacturers’ standpoint, but some of the ketchup might as well have any base as far as tomato flavor is concerned.

A variety of bottles are used, but two sizes, the 8- and 16-ounce avoirdupois for the contents greatly predominate. The former is packed 24 or 48 to the case and the latter 24 bottles to the case.

Preservative Ketchup

Ketchup is one of the products in which a preservative, benzoate of soda, may be used provided a declaration of the fact be made upon the label. Formerly that was the method commonly used for keeping both in the bottle and to resist infection after the seal was broken. The ketchups were generally thinner, contained less added vinegar, and were milder in spices than at present. The most comprehensive survey of the composition of ketchup is found in the report of the Dairy and Food Commissioner of Pennsylvania for the year 1912 and from that one can get a clear notion of the differences between preservative and non-preservative ketchups.

It is shown that of 106 non-preservative ketchups examined the average for the total solids was 25.09 per cent; soluble solids, 23.02 per cent; and total acidity as citric acid, 1.42 per cent. The highest figures for any one ketchup were: total solids, 37.20 per cent; soluble solids, 35.20 per cent; and total acidity, 1.50 per cent. The lightest ketchup showed total solids, 13.56 per cent; total acidity, .96 per cent. The highest acidity in any sample was 2.56 per cent; and the lowest, .48 per cent.

The preservative group comprised 36 samples. The average total solids was 22.29 per cent; soluble solids, 19.71 per cent; total acidity, 1.19 per cent. The heaviest sample gave total solids, 27.54 per cent; soluble solids, 25.10 per cent; and total acidity, 1.38 per cent. The lightest sample gave total solids, 17.91 per cent; soluble solids, 15.17 per cent; and total acidity, .84 per cent. The highest acidity in any sample was 1.80 per cent, and the lowest, .54 per cent.

It is evident from these analyses that there was less difference in ketchups in 1912 than had previously existed, and it may be added that the differences have become still less.

The manufacture of ketchup from canned pulp follows the same course as for fresh pulp except that cognizance is taken of the specific gravity of the pulp. If whole spices be used, the pulp is heated to near the boiling point and held there for half an hour or more to extract the flavor. If extracts or spiced vinegar be used, the work can be conducted without any delay and the remaining steps be the same as already indicated.
Chilli Sauce

Chilli, chili, or chile sauce, as one prefers to spell it, differs from ketchup in that the tomatoes are peeled and cored as for canning and then run through a chopping machine and cut finely. The seeds are not removed. More onions, garlic, and peppers are generally employed in the spicing to heighten the flavor. The cooking and handling are the same as for ketchup but the finishing operation is omitted.

The packing is most often done in bottles of a more squat type and a wider mouth than is used for ketchup.

Cocktail Sauce

Cocktail ketchup or cocktail sauce differs from regular ketchup in that the body is thinner, less sugar is used and it is made hot with pepper. Fresh red peppers, and crushed and ground sweet peppers, often take the place of the dried fruits.

Patented Process

Patent No. 1,402,136, January 3, 1922, issued to Wallace A. Beatty, New York, N. Y., is for a process of manufacture. The preliminary treatment of the tomatoes and the making of the pulp is the same as for standard procedure. The pulp may be evaporated in either the open kettle or in a vacuum pan until it reaches the proper specific gravity for the ketchup, which is generally 1.050 instead of 1.035.

The pulp is next placed in a closed kettle and the proper quantities of the other ingredients as sugar, salt, spices, and vinegar added. The kettle is then closed so that no evaporation can take place and therefore no loss of flavor. The cooker is preferably equipped with a steam coil and the cooking done at such temperature and for such length of time as may be found suited to the product.

The finishing and bottling is the same as for regular ketchup.

Factory Control of Ketchup

The making of ketchup according to the methods followed in chemical control is fully described by F. F. Fitzgerald and his paper is reproduced.

FACTORY CONTROL OF THE COMPOSITION OF TOMATO KETCHUP

By F. F. Fitzgerald
(National Canners' Association Laboratories)

The Committee on Standards, of the Association of Official Agricultural Chemists, has defined ketchup as the clean, sound product made from the prepared pulp of clean, fresh, ripe tomatoes, with spices and with or without sugar and vinegar.

Since ketchup is a condiment, and since the tastes of individuals differ greatly, it is about as difficult to fix a standard for ketchup as for salad dressing, sauces and like. However, at least partial specifications can and should be established. The character of the material should be clearly defined, and, if the grades are not determined on the basis of solids present, a minimum percentage of tomato solids should be prescribed.

But I desire to discuss, not the standardization of the products of different manufacturers, but the standardization of the brand of product of the individual manufacturer, for there is often a greater difference between the batches run on a single day by an individual ketchup maker than between the product of different manufacturers. Just what are the variations in composition?

The solid matter, or total solids, in ketchup varies from less than 12 per cent to over 37 per cent. This means the product varies from a substance having barely sufficient
tomato added to give color and taste, to a rich, heavy tomato ketchup. The variation of total solids in any one brand is, of course, less, but large differences are not unusual. Three bottles of one brand showed a solids content varying from 12 per cent to 16 per cent, and seven of another brand varied from 32 per cent to 37.2 per cent.

The variation in insoluble solids is comparable from 0.9 per cent to 2.3 per cent. The ash varies usually from 2 per cent to 4 per cent, owing to the addition of different amounts of salt. The acidity of ketchup varies from 0.43 per cent to 2.34 per cent. About half of this acidity is due to the citric acid contained in the tomato, and the remainder to the vinegar added. The variation in the acidity of the same brand is great, four samples showing values of from 0.8 per cent to 1.35 per cent. The sugar is derived from the sugar in the tomato and the sugar that is added, with the result that the variation in the amount present in the finished ketchup is as great as the variation in acidity.

Usually the ketchup maker adds the same weight of salt, onions and spices to each batch, irrespective of the volume of the finished product that will be obtained; hence, a uniform product does not result, nor can uniformity be expected by such methods. Moreover, commercial spices are not uniform in quality and the amount of flavor extracted from them in ketchup making varies greatly; no considerable improvement is possible until suitable spice extracts are placed on the market.

It goes without saying that ketchup of uniform color, consistency and taste can be produced only by controlling the quality and quantity of its constituents. Therefore, any satisfactory method of control necessitates the determination of the solids in the batch of cyclone juice, before sugar, salt, vinegar and spices are added. Control, based solely on uniform specific gravity of the finished product, assures only that the specific gravity is uniform; it does not assure uniformity in consistency, sweetness, acidity or in any other characteristic of ketchup as a condiment.

Uniform quality also demands uniform methods of factory manipulation or practice. If the ketchup maker in one factory breaks the tomatoes by steam, the product will necessarily differ from that obtained in a second factory where a mechanical breaker is employed. The first procedure will give a product with proportionately more body, which is due probably to a higher pectin extraction, but will also entail a sacrifice of color.

Since, under any specific procedure in a factory, the distinctive tomato flavor and the consistency of the finished product depend entirely on the tomato solids, and since about half the final acidity and sugar content is derived from the same source, the control of the tomato solid content is especially important.

Fortunately the solids in cyclone juice have a fairly uniform composition. The ratio of total solids to insoluble solids is fairly constant, likewise the ratio of sugar to acid. The sugar in cyclone juice varies from about 42 per cent to 54 per cent of the total solids, averaging about 50 per cent.

Any method of determining the solids in cyclone juice may be used, but the one best adapted for the purpose involves sampling the contents of a tank filled to a definite height with boiling pulp. The cyclone juice may be prepared by any method. The tomatoes may be broken by steam or mechanical breakers, and may be cycloned hot or cold. As soon as the coils of the evaporating tank are covered, the steam should be turned on and the cyclone juice should be run into the tank until the tank is filled to a pre-determined height corresponding to a known volume. Instead of filling the tank to any height and, after the contents boils, turning off the steam and measuring the volume by means of a gauge stick, it is preferable that the tank always be filled to the same height with boiling pulp. This may be accomplished by filling the tank slightly above the mark and evaporating to the desired volume. When this point is reached a sample is taken and strained quickly through a piece of muslin into a No. 3 sanitary can or similar receptacle, which, in turn, is placed in a bucket or larger receptacle containing cold water, preferably ice water. The muslin removes enough of the insoluble solids to permit the use of a Brix hydrometer and the ice water cools it to a temperature below 90° F., which is sufficient to prevent evaporation and permit the use of a correction table for the temperature of the filtrate. After the Brix reading is taken by a suitable hydrometer the temperature is read and the Brix reading corrected for the temperature.*

*This procedure is outlined in “Specific Gravity of Tomato Pulp” (second paper), Research Laboratories, National Canners’ Association. The temperature correction table is also given in this paper. Either Brix hydrometers giving direct specific gravity reading may be used. These should have a range from 4 to 10 degrees Brix, graduated to 1/10 degree, or the equivalent in direct specific gravity readings.
APPERTIZING
Filtrate from Pulp

Degrees
Brix at
68° F.
3.50
3.60
3.70
3.80
3.90
4.00
4.10
4.20
4.30
4.40
4.50
4.60
4.70
4.80
4.90
5.00
5.10
5.20
5.30
5.40
5.50
5.60
5.70
5.80
5.90
6.00
6.10
6.20
6.30
6.40
6.50
6.60
6.70
6.80
6.90
7.00
7.10
7.20
7.30
7.40
7.50
7.60
7.70
7.80
7.90
8.00
8.10
8.20
8.30
8.40
8.50
8.60
8.70
8.80
8.90

Specific
Gravity at
68° F.
1.0137
1.0141
1.0145
1.0149
1.0153
1.0157
1.0161
1.0165
1.0169
1.0173
1.0177
1.0181
1.0185
1.0189
1.0192
1.0197
1.0201
1.0205
1.0209
1.0213
1.0217
1.0221
1.0225
1.0229
1.0233
1.0237
1.0241
1.0245
1.0249
1.0253
1.0257
1.0261
1.0265
1.0270
1.0274
1.0278
1.0282
1.0286
1.0290
1.0294
1.0298
1.0302
1.0306
1.0310
1.0315
1.0319
1.0323
1.0327
1.0331
1.0335
1.0339
1.0343
1.0348
1.0352
1.0356

677

Added Constituents

Volume of
Finished
Ketchup
Gals.
226.0
232.0
239.0
245.0
252.0
258.0
265.0
272.0
278.0
285.0
292.0
299.0
306.0
313.0
320.0
327.0
334.0
341.0
347.0
354.0
361.0
368.0
374.0
381.0
388.0
395.0
402.0
409.0
416.0
422.0
429.0
436.0
443.0
450.0
457.0
464.0
471.0
478.0
485.0
482.0
499.0
506.0
513.0
521.0
529.0
536.0
543.0
550.0
557.0
564.0
571.0
578.0
585.0
592.0
600.0

Sugar
Lbs.
203
209
215

221
227
232
239
245
250
257
263
269
275
282
288
294
301
307
312
319
324
331
337
343
349
356
362
368
374
380
386
392
399
405
411
418
424
430
437
443
449
455
462
469
476
482
489
495
501
508
514
520
527
533
540

Vinegar
100-Grain
Gals.
18.1
18.5
19.1
19.6
20.2
20.6
21.2
21.7
22.2
22.8
23.4
23.9
24.5
25.0
25.6
26.2
26.7
27.3
27.8
28.3
28.9
29.4
29.9
30.5
31.0
31.6
32.1
32.7
33.3
33.8
34.3
34.9
35.4
36.0
36.6
37.1
37.7
38.2
38.8
39.4
39.9
40.5
41.1
41.7
42.3
42.9
43.5
44.0
44.5
45.1
45.7
46.2
46.8
47.4
48.0

Salt
Lbs.
45.2
46.4
47.8
49.0
50.2
51.8
53.0
54.4
55.6
57.0
58.4
59.8
61.2
62.6
64.0
65.4
66.8
68.2
69.4
70.8
72.2
73.6
74.8
76.2
77.6
79.0
80.4
81.8
83.2
84.4
85.8
87.2
88.6
90.0
91.4
92.8
94.2
95.7
97.1
98.5
99.9
101.3
102.7
104.2
105.8
107.2
108.6
110.0
111.4
112.8
114.2
115.6
117.0
118.4
119.0

Onions
Lbs.
33.0
34.8
35.9
36.8
37.8
38.7
39.8
40.8
41.7
42.8
43.8
44.9
45.9
47.0
48.0
49.1
50.2
51.2
52.1
53.2
54.2
55.2
56.2
57.2
58.2
59.3
60.4
61.4
62.5
63.4
64.4
65.4
65.5
67.5
68.6
69.6
70.7
71.8
72.8
73.8
74.9
76.0
77.0
78.2
79.4
80.4
81.5
82.6
83.6
84.7
85.7
86.8
87.9
88.8
90.0


Label Weights for Cans

28 per cent solids (Sp. Gr. 1.120). 8 Short, 8½ ozs.; 8Z Tall, 9 ozs.; Picnic—No. 1 East, 11½ ozs.; No. 300, 15½ ozs.; No. 1 Tall, 1 lb. 1 oz.; No. 303, 1 lb. 1 oz.; No. 2, 1 lb. 5 ozs.; No. 2½, 1 lb. 15 ozs.; No. 3, 2 lbs. 4 ozs.; No. 5, 3 lbs. 13 ozs.; No. 10, 7 lbs.

20 per cent solids (Sp. Gr. 1.080). 8Z Short, 8 ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 11 ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 14 ozs.; No. 3, 2 lbs. 3 ozs.; No. 5, 3 lbs. 10 ozs.; No. 10, 6 lbs. 12 ozs.


In the opinion of the bureau, catsup may be sold either by weight or by measure, in conformity with paragraph (f) of Food Inspection Decision 154.

Tomato Juice

The official definition for this product is as follows: "A tomato juice is the unconcentrated, pasteurized product, consisting of the liquid, with a substantial portion of the pulp, expressed from ripe tomatoes, with or without the application of heat, and with or without the addition of salt."

Tomato juice is one of the latest canned commercial products to be placed upon the market and is the direct result of studies upon vitamins. Tomato juice has been found to compare very favorably with orange juice in this respect and while first proposed as a substitute for the latter, it was quickly recognized for its own merits and quality. The first juice was placed on the market in 1925 and there has been phenomenal development in the process of manufacture and in the volume consumed. In ten years it increased so that 5,700,000 cases were packed in 1935.

Tomato juice is used as an appetizer and beverage and to supply vitamins, and as a beverage must have the maximum of the pleasing qualities both as regards flavor and appearance. This precludes the use of any but prime vine-ripened fruit, left on the vines one or two days longer than if used for canning. A more wrinkled fruit or variety, such as the Trophy, may be used than is profitable for canning but otherwise it must be free from cracks, rot, green spots, or other imperfections. It is even more important that the fruit have a naturally pleasing flavor and be not marred by green spots, over-ripe condition, rot, or molds. In no sense does this product give an outlet for lower grade fruit as near-culls or culls.

The best variety of tomato for the purpose has not been determined but that selected should preferably have a strong, clear, red color because of the favorable appearance, and a good tomato flavor inclined somewhat toward the acid side. The public has been taught to pay too much attention to appearance with the result that flavor has been sacrificed in some cases. The very early pickings should not be used, neither should those taken late in the season. Early pickings generally have a slightly bitter or acrid taste due to the inclusion of some green with uneven ripening through the body of the fruit. The late picking is inclined to be flat, more or less insipid in flavor, and with a thin body. This is more apparent in some varieties than in others.
The picking needs to be done when the fruit is fully ripe but still in the firm stage; that is, when it is best to eat directly from the vine. Ordinarily this stage is reached about one day later than picking for canning during hot weather and two days later if the weather be cool. If allowed to become soft or over-ripe, the juice is thinner and the flavor less piquant. Slight mold or decomposition will produce a musty or off flavor.

As far as may be possible, the fruit should be converted into juice the same day as gathered or at least not carried in crates or boxes more than a day if the best appearance, consistence, and flavor be the objectives.

The factory operations are relatively simple and follow essentially the same course as for making pulp. The tomatoes are dumped into a tank from which they pass to an inspection belt where any damaged fruit is removed, none being trimmed and returned. They pass under strong sprays, with fifty pounds water pressure or more, to remove every trace of dirt and continue past the crew who do the coring. That operation is best done by hand so as to get out all the hard portion with a minimum opening of seed cells. Machines are available which do very fair work with only about one-fifth or sixth the same amount of hand labor. The presence of the core in the crushed fruit imparts an objectionable flavor. The scalding should be carried out at a lower temperature than for pulping and continued long enough to raise the temperature above 125° inside the fruit. This softening puts the fruit in condition to obtain the maximum amount of juice without excessive fiber and favors the preservation of color.

Two types of juice extractors are available, one a modified pulper retaining the outer screen, but the regular beaters set back and aided by rolls which gently press the liquid portion through the screen. By this means pressure can be so regulated that only about one-half is reduced to juice and coring is unnecessary. The speed of the beaters is reduced to avoid incorporating air into the juice and in order to further reduce such action the tomatoes are drawn from the hopper through an opening near the bottom of the pulper and this opening is practically sealed with juice. Another precaution to prevent oxidation and destruction of the vitamins is to turn a small amount of steam into the extractor and keep the air saturated with moisture.

The other type of machine consists of a large screw inside a partially or entirely perforated cylinder. As the fruit is advanced from the hopper it is subjected to a gentle but increasing pressure, the total amount being dependent upon the size of opening left for the tailings. The movement is slow so that no air is incorporated. This type seems to be preferred where raw tomatoes are used but is suitable for either.

The juice is immediately drawn through a filter to remove any coarse fiber and run through a flash pasteurizer or into kettles in small batches of from 100 to 200 gallons, heated to about 200° and held until foaming ceases, which is generally about four or five minutes. Salt and sugar may be added at this point if desired. About 4 pounds of salt and 8 pounds of sugar to 100 gallons of juice make it more palatable to most persons. (According to the definition, the sugar would have to be declared.) It may be packed without any addition or with salt only or the combination and the exact proportions determined by trial in accordance with the variety of the tomato and the flavor desired.
A vacuum pan has some advantages over the open kettle as a preheater. A strong vacuum is drawn and heat applied to just start evaporation and the air is carried off at once. The vacuum is then cut off and the batch raised to between 180 and 190° F. The juice may be filled directly into containers and with little separation of liquids and solids though it is advisable to incorporate “shake before opening” on the labels. If the juice be bottled there will be some separation in the neck after three or four months. The separation is much less, however, than when the preheating is done in an open kettle.

After the preheating, the juice, whether prepared in the vacuum pan or open kettle, may be drawn into a homogenizer or viscolizer and further broken under a pressure between 1,000 and 1,500 pounds. The work is done so much more rapidly and effectively while the juice is hot that no time should be lost between the operations. The object is to break the particles so finely that they will not separate due to a difference in specific gravity. This is an adaptation of the same principle used in the evaporated milk industry. It contributes nothing but appearance, which is very important in glass-packed juice but not equally so for that in the tin container. The apparatus is expensive, adds to the cost of manufacture, so whether used or not depends upon the effort in making sales.

The cans or bottles are filled with hot juice and if the temperature be above 160° F. little head space is allowed. If the juice drops below that point, then reheating is desirable or allowance be made for it in the subsequent cooking.

The cans or bottles are sealed and if the preheating was brought to or above 205° for more than four minutes and the filling be done at 180°, it is claimed that inverting the can or bottle for three minutes to sterilize the closure is sufficient and that cooling is all that is necessary. Prudence suggests that cans of the No. 2 size or smaller be carried through a hot water exhaust box at 190° F. for 6 or 8 minutes, and that bottles of 24 ounces or less receive a like treatment for 12 to 15 minutes. It is more important to prevent spoilage than to conserve some of the other qualities. It is also important to test for spoilage even when there is no evidence of trouble.

There is little preference as to the use of plain or enamel-lined cans for the first three or four months after packing but later there is an increasing metallic taste in the juice packed in plain tin. Some deterioration of the juice has also been noted when packed in glass and the assumption is that it is due to the action of light but no experiments have been reported as to the exact cause.

**Label Weights. Fluid Ounces**

- 8Z Short, 7 ozs.; 8Z Tall, 7 3/4 ozs.; Picnic—No. 1 East, 9 1/2 ozs.; 12-ounce, 12 ozs.; No. 300, 13 1/2 ozs.; No. 1 Tall, 15 ozs.; No. 303, 15 ozs.; No. 2, 1 pt. 2 ozs.; No. 2 1/2, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; No. 10, 3 qts.

**Observation**

One of the fine things developed in connection with this work has been that flavor in the finished product is intimately connected with the state of maturity of the fruit, freedom from decay, and the amount of cooking given in the preparation. This is not new to the experimenters but con-
firms their work on a practical commercial scale. It points the way to improvements along other lines of fruit handling.

The definition already quoted provides that juice be not concentrated. One can readily understand why it should not be diluted, but slight concentration is necessary to standardize for quality. The tomatoes carry a varying amount of water upon the surface in passing from the washer or steamer to the crusher, and this naturally causes some dilution. The fruit will vary at ripening due to the variety, rainfall, lack of water, temperature, and the period in the harvesting season so that slight concentration is necessary to insure uniformity in the pack. The amount of pressure that it is desirable to use in making the extraction is an important factor and standardization can only be attained through concentration under some conditions.

Cocktails are juices to which more or less hot spices are added to give their characteristic flavor. There is no set formula but each manufacturer experiments until he obtains a product which meets his approval.

**Patented Process**

Patent No. 1,746,657 was issued February 11, 1930, to Walter Kemp, Kokomo, Indiana, contains the following:

This invention relates to the process of producing pure tomato juice for beverage or health purposes, wherein it may or may not be bottled or canned with suitable flavoring as salt or the like.

The object of the invention resides in the processing of tomatoes to obtain a pure and clear product in the form of juice having the tomato pulp and fibers incorporated therein in the form of small particles held in permanent suspension.

A further object of the invention resides in the processing thereof so as to maintain the juice in a homogeneous condition and prevent separation and precipitation of the solids from the liquid.

By means of this process, the minute particles of solids remain in substantially permanent suspension, giving the product a clear and uniform appearance and smooth taste. Furthermore, in bottling or canning the juice, there will be no separation or settling which is of material importance in the commercial product.

The process consists in extracting the juice of the tomato by compressing the whole tomato under constant pressure, and forcing the juice through a straining screen. By constant pressure is meant a pressure or force which is regular and which is exerted upon the material without any beating, stirring, or agitation thereof. This step in the process distinguishes from the usual practice of beating or whipping the tomato in a beater, by means of paddles or the like, and expelling the juice through a straining screen by centrifugal action and the impact of the whipping blades.

After the juice has been extracted and strained, it is viscous or homogenized by passing it through a homogenizing machine of the character commonly employed in creameries for breaking up fattish globules. The homogenizing process with respect to the tomato juice acts to break up and disintegrate any particles of pulp or fiber carried through the straining screen, and thoroughly incorporate such minute solids with the fluid, giving it a rich food-like character of high nutritious value and with a maximum of vitamins. Thus, a thicker and richer product is produced over the thinner fluid while having all the characteristics of a fluid by reason of the finely divided particles of solids which are caused to remain in suspension in the fluid by the homogenizing process.

The next step resides in pasteurizing the homogenized product by passing it through a flash pasteurizer of the character employed in creameries, which destroys and eliminates bacteria in the usual manner, and thereby permitting the product to be prepared for bottling or canning.

The resultant product as above stated, when bottled or canned, is such that the minute solids consisting of the broken particles of pulp and fiber will remain in suspension in the fluid over a long period of time, and are thoroughly incorporated therein so that to be rich in vitamins and food properties while having a smooth liquefied appearance and taste.
A special equipment for handling tomatoes for canning, preparing pulp and juice, is covered by patent No. 1,989,231, January 29, 1935, issued to O. Gilliate, Washington, Indiana. The tomatoes are sorted and those in prime condition for canning are placed on one line, those which are fully ripened and perfect are placed on the line to be made into juice, and others are trimmed and diverted to the pulp line.

The juice line has an apparatus for breaking the fruit and a screw to administer light pressure to extract only a part of the juice, thereby avoiding any bitterness while the heavy wet tailings are diverted to the pulp line.

**Examination of Tomato Products**

Tomato juice, pulp, ketchup, and paste being finely comminuted products do not divulge the nature of the raw materials used in their preparation upon a microscopic examination. A different technique is followed, one announced by the Bureau of Chemistry in Circular 68, and generally known as the Howard Method. It is based upon a microscopic examination of the product using certain types of lenses, powers of magnification, and measuring device, and it is assumed that one can positively differentiate organisms as bacteria, yeast, spores, and molds from all other material which may be present, that the number of organisms can be expressed with a fair degree of accuracy and that if the count exceeds certain arbitrary numbers the product must necessarily be made up in part or in whole of "filthy, putrid, and decomposed" material.

The method was designed so as to be able to go into court and give a definite statement as to the conditions present in a given sample. The objective is an admirable one and if the results of such examinations always corresponded with the nature of the product, and could be obtained by a number of persons working independently with the same material, then the method might be considered well suited for the purpose. It is an empirical method based upon one used in yeast studies and blood counting, but in which the conditions are very different from that in ketchup. The Howard method is used by chemists, so has a scientific aspect to the uninformed. It has a certain value in factory control as has any method which directs closer attention to any detail of operations.

Since the manufacturer is the one cited to hearings and haled into court as violator of the pure food laws, he is entitled to know the nature of the evidence and whether it is reliable. If it be criminal to unconsciously offer unclean food in trade, it is no less an offense against him to be accused and prosecuted upon highly technical evidence about which there is much doubt concerning its accuracy. Furthermore, the manufacturer is entitled to employ a trained person or persons to use the same technique as published to examine his product with the assurance that there will be reasonably close agreement in results, something which has not been possible, and thus has created more disrespect for the enforcement of the law than in all its other operations.

The technique of the method was originally given in Circular 68 (February 11, 1911) of the Bureau of Chemistry, by implication approved in Service and Regulatory Announcement No. 184 (1922) with an additional
statement giving the number of organisms which would be tolerated before recommending seizure or other action. The most recent action, January 25, 1934, incorporates standards developed by this method in the definitions of pulp and ketchup. The methods used in the examination are as follows:

**Methods of Micro-analysis and Interpretation of Results**

The methods used for determining the character of pulp or ketchup are given, since inquiries are repeatedly received for this information. Unfortunately they are of such character that the manufacturer without scientific training cannot use them to any great extent, though with practice a layman might be able to judge roughly in some particulars as to the character of the product.

**Apparatus Required**

The outfit used is as follows: A good compound microscope giving magnifications of approximately 90, 180, and 500 diameters. This is accomplished by the use of a 16 mm. (two-thirds of an inch) objective and an 8 mm. (one-third of an inch) objective, together with a medium (x6 compensating) and also a high-power ocular (x18 compensating). A Thoma-Zeiss* blood-counting cell, a 50 cc. graduated cylinder, and ordinary slides and cover glasses complete the apparatus required. It is impractical to use objectives of a higher power than those mentioned, because of their short working distance, which makes their use with the counting cell impossible.

**Estimation of Molds**

A drop of the product to be examined is placed on a microscope slide and a cover glass placed over it and pressed down till a film of the product about 0.1 mm. thick is obtained. After some experience this can be done fairly well. A film much thicker than this is too dense to be examined successfully, while a much thinner film necessitates pressing the liquid out, which gives a very uneven appearing preparation. When a satisfactory mount has been obtained, it is placed under the microscope and examined. The power used is about 90 diameters, and such that the area of substance actually examined in each field of view is approximately 1.5 sq. mm.

A field is examined for the presence or absence of mold filaments, the result noted, and the slide moved so as to bring an entirely new field into view. This is repeated till approximately 50 fields have been examined, and the percentage of fields showing molds present are then calculated. Our experience has demonstrated that for home-made ketchups this is practically zero, and with some manufactured ketchup it is as low as from 2 to 5 per cent, while for carelessly made products it may be 100 per cent; that is, every field would show the presence of mold. Investigations under factory conditions clearly indicate that with only reasonable care the proportion of fields having molds can be kept below 25 per cent. A specimen in which 60 per cent of the fields have molds is in more than twice as bad a condition as one containing 30 per cent.

After the percentage reaches 30 to 40 per cent it will be found that some of the fields frequently have more than one filament or clump of mold, and the number of such fragments might be counted, but in this laboratory this usually is not done. A Thoma-Zeiss counting cell with a center disk of 0.75 inch instead of 0.25 inch, as usually furnished, would give a regular depth of liquid and would be more exact than the method described, but this must be especially manufactured, not being listed in any of the catalogues of microscopic supplies, and the method as given is sufficiently accurate for the purpose. When the number of fragments of mold per cubic centimeter is estimated, it has been found to range from virtually zero to over 20,000. There is no excuse for a manufacturer allowing such conditions to prevail that his ketchup shows more than 2,000 per cubic centimeter, while some manufacturers by careful handling hold it down to 150.

**Estimation of Yeasts and Spores**

Though the spores referred to are those coming from molds and correspond to seeds in some highly developed plants, it is frequently very difficult to differentiate some of them with certainty from some yeasts without making cultures, which is obviously

*This is a cell named after the designer of the form of rulings used, and consists of a slide with a disk ruled in one-twentieth mm. squares, so arranged that when the cover is in place the film of liquid under examination is one-tenth mm. deep. They were originally intended for counting corpuscles in the blood and are obtainable from practically all manufacturers of microscopic accessories.
impossible in a product that has been sterilized by heat. For this reason the yeasts and spores have been reported together, and if there seemed to be a larger percentage of the latter, mention was made of that fact.

To make a count, 10 cc. of the product is thoroughly mixed with 20 cc. of water, and after being allowed to rest for a moment to permit the very coarsest particles to settle out, a small drop is placed on the central disk of the Thoma-Zeiss counting cell and then covered with a glass. Care must be exercised to have the slides perfectly clean, so that, when the cover glass is put in place, a series of Newton's rings result from the perfect contact of the glass surfaces; and, furthermore, the drop should be of such size as not to overrun the moat around the central disk and creep in underneath the cover glass, thus interfering with the contact.

With the magnification of 180, it has been the practice in this laboratory to count the number of yeasts and spores on one-half of the ruled squares on the disk. With the dilution used this calculates back to a volume equal to one-sixtieth of a cubic millimeter in the original sample, and reports are made on that basis rather than on the number in a cubic centimeter, because the former number is more readily grasped by the mind and affords a simpler notation. To obtain the number per cubic centimeter the count made is simply multiplied by 60,000.

It has been found in practice that the number of yeasts and spores varies, for one-sixtieth of a cubic millimeter, from practically none in homemade and first-class commercial ketchups up to 100 or 200, and in one sample the number was as high as 1,200. Laboratory experiments show that when the number of yeasts in raw pulp reaches from 30 to 35 in one-sixtieth of a cubic millimeter the spoilage may frequently be detected by an expert by odor or taste, and from experiments made under proper factory conditions, it seems perfectly feasible to keep the number in commercial ketchups below 25.

**Estimation of Bacteria**

The bacteria are estimated from the same mounted sample as that used for the yeasts and spores. A power of about 500, obtained by using a high-power ocular, is employed in this case, and because of the greater number present a smaller area is counted over. Usually the number in several areas, each consisting of five of the small-sized squares, is counted and the number of organisms per cubic centimeter is calculated by multiplying the average number in these areas by 2,400,000. Thus far it has proved impractical to count the micrococci present, as they are likely to be confused with other bodies frequently present in such products, such as particles of clay, etc. A comparison of this method with the ordinary cultural methods on samples in which the organisms had not been killed has almost invariably shown that the one used gives too low instead of too high results. In some cases it was found to give not more than one-third of the entire number present. The estimates of the laboratory on this point may, therefore, be considered very conservative.

As regards the limits which may be expected in the examination of ketchups for bacteria, it might be stated that some manufactured samples as well as good, clean products made by household methods, have been examined and the count found to be so low when estimated by this method that the numbers present were reported as negligible. In other words, it was found that for the areas counted over the numbers of bacteria averaged less than one; that is, less than 2,400,000 per cubic centimeter. It is unusual, however, for the final number per cubic centimeter to be less than 2,000,000 to 10,000,000 organisms. Contrasted with this number as a minimum, it has been found that the number has occasionally exceeded 300,000,000 per cubic centimeter. Such a number as this would indicate extremely bad conditions and carelessness in handling, as the studies of factory conditions has shown that there is little excuse for the number ever exceeding 25,000,000 per cubic centimeter. While experiments have shown that although the effect produced by the bacteria on the product varies with different species, it is true that their presence can frequently be detected in the raw pulp by odor or taste when the number exceeds 25,000,000 per cubic centimeter, and sometimes when the count is as low as 10,000,000.

To one who has not been initiated into the mysteries of the microscope the presence of such a number of bacteria in a food product seems inexcusable. It must be remembered in this connection that the most of these are probably nonpathogenic forms, and many occur naturally on the skin of the fruits. It does not seem just to set a standard so high as to virtually prohibit the manufacture of the product under commercial conditions; rather the idea is to set a limit that the manufacturer can attain if due care is
exercised and which will insure a cleanly product. It is, however, perfectly possible to make a cleanly, wholesome product commercially even though the number of bacteria exceed that in the homemade article.

The allowable limits for the bacterial content of tomato pulp vary according to the concentration. The number, however, should be low enough so that when the amount of concentrating necessary for its conversion into ketchup has been accomplished the final product will still be within permissible limits (25,000,000 per cubic centimeter). Thus for a pulp which must be concentrated, one-half the bacterial counts should not exceed about half the limits stated above for ketchup itself, i.e., it should not be more than 12,500,000 per cubic centimeter. The same general rule should also apply to the content of molds and of yeasts.

To insure a sound product, free from decay or any filthy material, many factors must be carefully watched, for not infrequently oversight in one particular has been found to have undone the good effects of the care exercised in all other ways. Thus it is possible for the washing of the fruit to be ideal and the sorting out or removing of the decayed portions beyond criticism, and yet a delay in making up the pulp into the final product may allow an amount of decomposition to occur which offsets the care previously exercised. It has been a matter of surprise to some manufacturers to find with what rapidity some of these organisms increase. In one factory where this point was tested, the bacterial content in a batch of tomato trimming juice was found to be about 7,000,000 per cubic centimeter when taken from the peeling tables, and after standing at room temperature for five hours it had increased to 84,000,000. This was a twelvefold increase in a length of time which was less than half the working day for some of the factories visited. At the end of five days the number had increased to nearly 3,000,000,000 per cubic centimeter. Thus it is seen that delay in manufacture is very liable to result disastrously.

Such facts as these serve to emphasize the great importance of absolute cleanliness in every detail about factories of this kind. Dirty floors and ceilings and apparatus left with residues of tomato product clinging to them are most fruitful sources for the contamination of new batches of the product. To clean such an establishment properly it is almost imperative that machinery and woodwork be washed by means of live steam used lavishly at frequent intervals. To leave buckets, tables, conveyors, or any other part of the equipment or floors over night without cleansing them, as was the practice in some factories, is reprehensible and tends to contaminate the product and lead to spoilage and loss.

The method, known as the Howard method, was developed in the Bureau of Chemistry and accepted as so nearly infallible that hundreds of prosecutions were instituted against tomato products, charging that they were composed in whole or in part of filthy, putrid, and decomposed material. No chemical tests were developed to confirm the results though attempts were made to do so.

There are factors in both the technique of the examination and in the process of manufacture of tomato products which may influence the results of the counts and to such an extent as to create honest doubt concerning its credibility as a means of establishing the status of a product before a court. These may be summarized as follows:

First. The method is based upon an attempt to adapt a method used in the examination of blood for the number and kind of corpuscles, and also of yeast cells in a culture but without incorporating the factors necessary for accuracy found essential in both of these lines. Blood corpuscles and yeast cells are both much larger than bacteria and in both the menstruum in which they are suspended is clear having no foreign material present with which they may be confounded. The solids and media in each case are of very nearly the same specific gravity so that in taking a sample and making a dilution the diluting material is made to have the same specific gravity as the original or as nearly so as practical. The sample is drawn with a special pipette, mixed with the diluent and at once transferred to the count-
ing chamber to be certain that it is a representative sample. The taking of
the sample is a matter of the greatest importance both for getting a true
picture of the condition of the blood in certain diseases, and for the proper
control of certain fermentation processes.

The lack of similar precautions in preparing samples for the examination
of tomato products introduces errors which are not negligible. Disregarding
the time and amount of shaking the sample, allowing a variable period
for standing, using a diluent of very different character and specific gravity
from that of the material under examination, and transferring the sample
with a knife blade, match stem, toothpick, pencil point, glass rod, medicine
dropper, pipette, or the tip of the finger introduces errors not tolerated in
careful biological work. The first requisite for such an examination is a
representative sample and unless there be uniformity in preparation the
results are little better than guesses, and bad guesses at that, when multi-
plied by the factor 2,400,000 as used for bacteria.

Second. The method is based upon the assumption that one is able to
differentiate unerringly between particles of plant tissue in the sample and
micro-organisms. This is not possible with the magnifications used and par-
ticularly in fully ripe fruit when the cell contents are torn apart by the
pulping machines and cooking. If one cannot make the distinction with
certainty, the result can only be a guess.

Third. Only a part of the organisms are counted, such as the larger
bacilli, and thus it becomes a matter of judgment for each examiner where
to draw the line. Even the author condescends not to count micrococci be-
cause they may be confused with "particles of clay." Others find it difficult
to distinguish between protoplasmic threads and bacilli, between bacilli and
tissue when they are in immediate contact, or clumps whether they be
organisms or tissue. In bacteriology it is usual to stain mounts in order to
differentiate between organisms and tissue. If slides of pulp or ketchup
be prepared in the usual way, some stained and some not, and examined
with the oculars recommended, the results will not agree. If one uses
higher magnifications as usually employed by bacteriologists, the discrep-
ancies are widened and all cannot be right. It is evidence of defective tech-
nique. If a product be necessarily filthy, putrid, or decomposed because of
the presence of bacteria in excess of a certain number irrespective of any
changes which they effect, then there should be no guessing in making the
count.

Fourth. No distinction is made between organisms which are normally
present on the surface of sound fruit and the wide variations which occur
among them under certain conditions and those which are associated with
decomposition.

Fifth. No one using the method has ever reported being able to add 10,
20, 50, or any other number of millions of bacteria to a sample of pulp
which had been counted by the Howard method, then cook the material as
in a manufacturing process and recover the original number plus the added
number. A sugar chemist expects his analyses to be so nearly exact that if
he adds a known amount of sugar to some mixture, he will recover the
entire amount within the experimental error of manipulation. The dairy
chemist expects to do the same thing in the case of milk fat, or discards
the method if it fails. If a counting method cannot be developed corre-
sponding to the simplest prepared material, it is not unreasonable to question the accuracy in unknown material.

The foregoing observations apply particularly to the bacterial examination of tomato products but apply in a lesser degree to the examination for yeasts, spores, vegetative cells, and mold hyphae.

The differentiation between tissue fragments and micro-organisms requires a knowledge of plant histology and a training in microbiology. It is not easy for those who have spent years in such study and is innately little more than guesswork when the work is attempted without such a background. As far as can be learned no such group has ever endorsed the method.

The methods followed in the manufacture of the several tomato products have a marked influence upon the organisms present in the finished product.

A. Fruit which is well vine-ripened is best for the highest grade pulp and ketchup, but vine-ripened fruit always carries a normally higher microbial flora than hard-ripe fruit which is less mature. This is further influenced by a smooth polished surface skin or one which is soft and almost absorbent, a wrinkled or globular form, dry field, heavy dews or rains, temperature, sunshine, or cloudy weather. This is easily demonstrated by taking the peel from sound fruit at different times and under different conditions and reducing it to pulp separate from that made from the flesh. By the Howard method one might be classed as composed in whole or in part of filthy, putrid, or decomposed material and the other passed though nothing occurred to change the composition. The natural result is that manufacturers use more and more hard-ripe and under-ripe fruit to the detriment of their products in order to comply with this arbitrary test.

B. Thoroughness in washing is the most important factor in removing surface organisms. Fruit which one would eat directly from the vine, if made into pulp will reveal many more organisms than if thoroughly washed under strong sprays but it does not necessarily follow that the material which shows the greater number of organisms is filthy, putrid, or decomposed. This is not an argument for not doing the best possible job of washing but to point out that false deductions may follow from being guided by counts.

C. The effect of comminution, whether obtained by softening the entire fruit, scalding the skin and then crushing, whether pulped by close rubbing to get dry tailings or with the beaters set back to deliver all hard parts as green spots and cores over the end, and whether finished on a vibrating screen or in the pulper type of sieve and the size of the openings, all have an important effect upon the appearance of the fields under the microscope. Until all samples are run through screens with the smallest size opening commonly used in manufacture, and the pulp worked through by beaters running at a definite speed, it is not possible to get comparative readings. The Howard method does not take cognizance of these manufacturing factors as having any effect upon the counts. It ought to appeal to analysts that it is just as important to have uniform samples of pulp or ketchup in making an examination as it is in preparing a sample of fertilizer to determine its composition.
D. The rate at which concentration is carried out has an effect. In general the more rapidly the work is done, the lower will be the count. Ketchups made in less than forty minutes will have a lower count than if the work be done in an hour and a half, other conditions being the same. Apparently in the short cooking period the combination of the fruit, vinegar, and sugar produce an effect that causes the organisms to adhere more closely to the tissue cells so that they cannot be so readily recognized. Long cooking favors a more watery condition in the pulp or ketchup. On this same score hard-ripe fruit has an advantage over fully ripened fruit.

E. The higher the concentration, the higher the counts though the increase may not follow in the same ratio.

F. The effect of added substances as sugar in ketchup, and flour or starch in sauce or soup change the appearance from that of the original pulp.

There are other factors which have an effect but the foregoing should be sufficient to indicate that with so many variables the results are open to question as to accuracy in determining whether a product is composed in whole or in part of a filthy, putrid, or decomposed substance.

The sufficiency of the method was questioned and the matter referred to an able botanist and bacteriologist in the Department of Agriculture. In 1915 he reported adversely to its use in establishing beyond doubt the nature of the materials used in tomato products.

Variation in Counts

It was early evident that microscopists following the printed directions and some of them the personal instruction of the author could not get concordant results. A group of analysts, presumably the best in the country at the time, working upon the same samples of tomato products, obtained variations in counts which are reported by W. D. Bigelow. The following is quoted: “These results show the widest possible variation. For instance, on Sample A the mold content reported by different analysts varied from 6 to 90 per cent of the fields. The bacteria count varied from 6,000,000 to 168,000,000 per cc. while the content of yeast and spores varied from 1 to 208 per 1/60 cmm. In Sample I, the mold count varied from 4 to 100 per cent of the fields, the bacteria count from 8,000,000 to 115,000,000 per cc. and the content of yeast and spores varied from 0 to 850 per 1/60 cmm. Similar variations will be noted in the other samples given in these tables.”

Slight variations as 1 to 15, 1 to 24, and 1 to 208 times are of no consequence in a method which is chosen to sustain a prosecution. Whatever “psychological effect” it may have in a general way in improving factory technique, it is facts which should be presented to a court when a manufacturer’s product or his reputation is placed in jeopardy.

A review of the seizures will show that in the beginning most emphasis was placed upon the bacterial count, then for a short time upon yeasts and spores but now and for some years upon the molds. In order to more firmly fix the status of the method it is made a part of the definition of tomato juice, pulp, and catsup.

Circular No. 68 does not divulge figures as a basis upon which action will be taken as indicating unfit material in a product but indicates that
it is the belief that with reasonable care manufacturers can hold the counts below the following figures:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Molds (per cent of fields)</td>
<td>25.</td>
</tr>
<tr>
<td>Yeasts and spores (in 1/60 cm.)</td>
<td>25.</td>
</tr>
<tr>
<td>Bacteria (per cubic centimeter)</td>
<td>25,000,000.</td>
</tr>
</tbody>
</table>

As it finally worked out the figures were raised to:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Molds (per cent of fields)</td>
<td>66.</td>
</tr>
<tr>
<td>Yeasts and spores (in 1/60 cm.)</td>
<td>125.</td>
</tr>
<tr>
<td>Bacteria (per cubic centimeter)</td>
<td>100,000,000.</td>
</tr>
</tbody>
</table>

In the early seizures, much was made of the yeasts and spores and then less attention was given to these factors and stress placed upon the bacterial count, and now greatest dependence is placed upon the mold count.

A review of state food reports shows that the method is not used as much as formerly.

Canned tomatoes and tomato products have received special attention at the hands of the food authorities. A review of the federal food and drug cases from the beginning until 9,500 had been disposed of showed these products, which constitute such a small proportion of the food used, had been subject to action 884 times or made up practically 9 per cent of the total, that 80 per cent of these were against the comminuted products. Then a very sudden drop occurred in prosecutions, and in the next 6,000 cases there are 250 or only 4 per cent. In the first group more than 300 firms were brought into court, scores of which packed varied lines in the same factory and with the same personnel and no question raised with regard to the other products. One may also draw the conclusion from the same data that the packing is very different in adjoining states for in a period of eight years, Indiana canners scored 52 times as many cases as Kentucky or Ohio, 13 times as many as Michigan, and 3 times as many as Illinois.

S. R. A. 184. Examination of Tomato Products.

The Department of Agriculture has been requested to inform manufacturers and dealers in tomato products of the tests which it applies in arriving at its decision whether to recommend proceedings under the Food and Drugs Act against tomato products.

Under section 7 of the act articles of food are adulterated if they are found to consist in whole or in part of filthy, decomposed, or putrid animal or vegetable substances. In Circular 68 of the Bureau of Chemistry there were announced the number of yeast and spores, bacteria, and molds which, in the opinion of the department, may ordinarily be found in tomato products handled with reasonable cleanliness in the process of manufacture. Examination of a large number of tomato products and tomato canneries convinces the department that it is entirely practical for manufacturers to keep the yeasts and spores, bacteria, and molds within the limits stated in Circular 68. Though the department has not recommended proceedings under the Food and Drugs Act unless the product, upon examination under the conditions prescribed in Circular 68, was found to contain yeasts and spores, or bacteria, or mold filaments in excess of the following numbers: Yeasts and spores per 1/60 cubic millimeter 125; bacteria per cubic centimeter 100,000,000; mold filaments in 66 per cent of the microscopic fields, it is considering the adoption of figures approaching those given in Circular 68. When such a scale has been adopted public announcement will be given.

Since Circular 68 was issued there are being produced in increasing quantities tomato products of varying degrees of concentration. The department is considering the adoption of a scale for testing tomato products, varying with the degree of concentration. If it be decided to adopt such a scale, public announcement will be given.

It has come to the attention of the bureau that tomato sauce, which is used largely as a dressing for various articles of canned food, is sometimes thickened by the addition of starch. The bureau is of the opinion that starch is not a proper ingredient of such tomato sauce.

**TURNIP**

*Brassica rapa*

By some botanists, the turnip is believed to have the same ancestry as the cabbage but with the deviation from the parent type along the line of root development instead of leaf development as occurs in the domesticated cabbage. It is not nearly so ancient in usage nor in cultivation as the cabbage. It has been developed in northern Europe where it constitutes an important item of food for both the people and their stock. Here it is of secondary importance.

The turnip used for canning is preferably of a small, sweet variety as the larger ones are generally rather coarse, woody, and with a tendency to develop a strong, hot flavor. The seed is sown late in the summer in order to have the root develop when cool weather comes on in the fall thereby retarding growth but favoring tenderness and sweetness. They are frequently grown in corn fields between the rows of corn, the seed being sown broadcast. The crop is thus obtained without any extra cultivation. The roots are pulled when only about an inch and a half in diameter.

Canning operations follow closely along the same lines as beets, pulling, topping, grading for size, and washing in the preliminary steps. It is rather important that these be carried out promptly before any drying or wilting occur as, under these latter conditions, the skin toughens and is much more difficult to remove. The peeling can be done in a centrifugal machine, but it leaves the surface somewhat fuzzy. Another method is to drop them into scalding water for four or five minutes when the outer skin can be rubbed off with a brush or a rough cloth. After turnips become wilted, the peeling becomes more difficult, and the cost increased because of hand trimming. Some packers do not peel the turnip but depend upon the cooking to soften the skin to the point that it is not objectionable.

The turnip needs to be thoroughly blanched, preferably by steaming as a brighter color is obtained than when heated in water. Six minutes steaming, filling the cans hot, and then exhausting for an additional five minutes or more will do much to prevent the dull leaden hue usually present. If the turnips are unpeeled, they can be filled into the cans hot, but if peeled, a test batch should be made with some cans filled hot and others given a cold spray to determine which is better before proceeding with the regular pack. The 1½ per cent brine is added hot.

The cook should not exceed 240° F., as higher temperatures increase the tendency toward discoloration. While we know of no experiments to determine the time needed for sterilization, experience has shown that 30 minutes are sufficient and at the same time give the proper cook to the turnips. This applies to the No. 2½ can. The No. 10 cans will require ten minutes longer. Owing to the spaces between the individual turnips, heat penetration is easy.
Larger turnips are sliced or cut in various ways and require a slightly heavier cook.

Canned turnips have been imported for hotel use for many years but domestic packing is now taking their place.

The turnip does not rank very high in nutritive value. The composition as given by Wiley is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>90.46</td>
</tr>
<tr>
<td>Ash</td>
<td>.80</td>
</tr>
<tr>
<td>Protein</td>
<td>1.14</td>
</tr>
<tr>
<td>Fiber</td>
<td>1.15</td>
</tr>
<tr>
<td>Sugar, starch</td>
<td>6.27</td>
</tr>
<tr>
<td>Fat</td>
<td>.18</td>
</tr>
</tbody>
</table>

**STRAINED FOODS**

Strained or puréed foods, frequently called “Baby Foods,” has become a specialty of considerable importance. Purées have been canned for a long time but attracted no particular attention until it was found that certain foods rich in vitamins were beneficial to young children. The highly com¬
minuted condition of strained foods freed from fiber seemed the logical method of supplying the need and they were promptly designated “Baby Foods.” They could be used at an earlier age than in the usual form. It was found that older children and adults, particularly when recovering from illness responded favorably to this form of food administration so that the broader termed strained is now more generally used.

The commercial preparation of this specialty seems to have been started by Harold H. Clapp, Rochester, New York, in 1922, the result of follow¬
ing a prescription for an infant food requiring a cereal, beef stock, and a strained fresh vegetable. The amount of time and labor required to make the very small quantities of food required each time led to canning small batches in the home and from this to supplying neighboring families. Mr. Clapp decided that by preparing such foods from the choicest materials and to definite formula that their quality and convenience warranted a special business.

Competitors followed and expanded the list to include a wide variety of vegetables to supply mineral matter and vitamins as shown in the items described in the Journal of the American Medical Association. The vege¬
tables include asparagus, beans, beets, carrots, celery, okra, peas, spinach, and tomatoes. They are grown as special crops, harvested when in their prime, hurried to the factory without delay, washed, and steamed in a closed chamber until softened to permit working through a pulper. By steaming instead of blanching, more of the mineral constituents are re¬
tained and by pulping in a saturated atmosphere the maximum of vitamins are conserved. Concentration, if necessary, is done in a vacuum pan.

The fruits most used are the apricot, apple, and prune, the first two tree¬
ripened and the prunes soaked and steamed until soft.

The packing is done in small cans, No. 1 or less. The matter of labeling should be taken up with the Bureau of Chemistry.
THE CANNING OF SPECIALTIES
MACARONI AND SPAGHETTI

Alimentary pastes, the well known macaroni and spaghetti and their various cut forms, and noodles, constitute important articles in the dietary among certain people, and particularly those of southern Europe. While they are minor items in this country, their use is growing constantly.

The origin of paste dates from very early times, no one knows to a certainty just when or where. Both the Chinese and Japanese claim to be the originators with the evidence seeming to favor the former. Renato Rovetta, in “Industria del Pastificio o dei Maccheroni,” states that paste was made in Pe-tche-le, China, 5000 B.C., and that at that time was made from rice meal.

Whatever may be the true story of the origin of this food product, its introduction into Europe was by the Germans as a result of contact with the Chinese near the end of the thirteenth or the beginning of the fourteenth centuries. The Italians learned the method of preparation from their northern neighbors, and because of the better quality of the Italian wheat for the purpose, exceptional drying conditions, and aptitude in developing mechanical appliances, they made a superior quality of paste. The result was that from the fourteenth century to approximately the middle of the nineteenth they virtually held a monopoly on European production. There were two centers of development, Sicily in the south and Genoa in the north.

Manufacture grew to such an extent that outside supplies had to be used and semolina flour was obtained from the important flour mills at Marseilles. The French observed that a handsome profit was made by the Italians on the flour which they bought and returned to them as macaroni so decided that they might retain this by making the paste themselves. They purchased Italian machinery and became real competitors about 1850. Factories were also started in Switzerland and other places but these made slow progress due to not having equally good wheat and through lack of experience in manufacture. Italy retained her lead both in manufacture and in consumption. Macaroni had become the national dish—an extremely important article in a wholesome but economical diet and a distinctive item in their commerce. Domination was so complete that the Italian names of nearly all the forms have been adopted into other languages with little or no change. Macaroni, first spelled maccaroni, and maccheroni, from the Italian ammaccare, maccare, to bruise or crush, which came into use just prior to 1600, is typical of all the pastes and the two score or more forms have their appropriate designation. There are other derivations given as from (1) Macco, a character in an ancient comedy, and (2) Pun, a gourmet, hard to satisfy, terror of his cook, took great pleasure in a new dish, but when he discovered how difficult it was to make and then the price, he exclaimed: si buone macaroni, that is why they called it macaroni in Naples but in the rest maccheroni. In Italy they call a sot or lout a maccherone. It is in this sense that Cavour in the Neapolitan campaign, 1860, wrote in a letter, “The macaroni (the Neapolitans) are not yet boiled.”
Development in Manufacture

The making of all pastes prior to 1800 was wholly a hand operation. The flour and water were mixed in a dough trough and when completed the dough was spread on top of a specially strong, heavy table and rolled until it was of the desired thinness. It was then cut into ribbons of different widths, the narrowest being called tagliarini and the widest lasagne, or the dough might be cut into pieces and folded, twisted, or stamped into different shapes according to the skill of the workman, each form being given a descriptive designation.

The first departure in the way of mechanizing the manufacturing process was the adoption of the screw press about 1800. A dough holder was constructed of heavy oak or walnut planks bolted together in the form of a short, square tube with a copper piston made to fit. A long bar projected from the screw portion of the press and two men pushing and pulling on the end of the bar exerted pressure on the piston. The bottom of the dough holder had holes or slits cut into it so that the dough on being forced through the opening would be of the shape and size desired.

An early variation was to mount the press in a horizontal position and attach a large wooden wheel or frame to the screw. This wheel was about sixteen feet in diameter and men climbing on the rim caused it to turn and drive the piston.

Other improvements naturally followed, first in making the piston and screw of bronze about 1840, then of cast iron in 1850. The first hydraulic press was put into use in 1870. Second, metal replaced the wooden dough holder simultaneously with the advent of the more powerful presses.

Two other developments are of interest though of no practical use at present. One occurred in Naples in 1830 and consisted in providing a very heavy table which was anchored to the floor. On one end of the table was fastened a large hinge or hook into which was engaged the end of a heavy beam. The beam was made thick for the length of five or six feet or corresponding to the top of the table and the remaining fourteen or fifteen feet extending beyond the table was tapered but of sufficient strength to carry three or more men. The beam could be moved up and down also sidewise, exerting much force. The dough was placed upon the table and kneaded and flattened by men jumping up and down on the beam or riding it sidewise. The other development occurred in Sicily and consisted in dressing a stone about eight feet in diameter and two feet thick to a true disk. The circumference was cased with wood. This huge weight was rolled back and forth over the paste on a special table.

The different methods of forming the paste necessitated differences in making the dough, the chief of these being the use of cold water to make hard paste and hot water to make the soft or more flexible paste.

The early pastes were made from whole meal and this was continued for a long time after bolting of the bran became a regular part of the milling of white flour. Bolting gradually became a part in the milling of macaroni flour and is universally followed unless otherwise specified. Bolted flour gives a fine white semi-translucent product in popular demand.
Introduction of Manufacture in This Country

Credit for the introduction of the manufacture of paste into this country belongs to Christian F. Mueller, Jersey City, New Jersey. He was a German baker who came as an immigrant in 1866, just after the civil war when times were bad. He did not prosper any too well in his trade, and to add to his income he prepared the home-made style of German noodles which was followed in due time by the Italian style of pastes. His business expanded slowly but steadily and in 1885 he equipped a small factory, though a macaroni press was not imported until 1894. This first press had a capacity of only 500 pounds per day. Additions were made to the factory and equipment at short intervals, always keeping in the lead and at present it is the largest plant in the country. The government began the introduction of durum wheat, the kind high in semolina content, about 1890, which was found to be well adapted to the dry lands, so that supplies quickly became available for domestic requirements as well as for export. An earlier recommendation by the Patent Office (1849) that hard Russian wheat be imported and tried had been ignored. From the beginning just described, production has expanded to more than 500,000,000 pounds annually with a daily consumption in excess of one and one-half million pounds.

Manufacture

Pastes as generally understood in the trade, are preparations from semolina, the hard glutinous part of the wheat grain, which is coarser than from the product obtained from breaking the starch and is held back by the bolting cloth. It makes up part of the middling used in breakfast foods. There is a small quantity in all wheat flour but certain strains of hard wheats are particularly rich in this substance and have been bred for this quality. This is notably true of durum wheat grown in dry countries. The plant does not yield abundantly, the grains are hard, flinty, reddish, and more or less translucent or so distinctive that they are frequently called semolina or macaroni wheat. The grain is not so good for flour as ordinary wheat and therefore less valuable in commerce. The finest of such wheats are grown in Russia and yield up to 60 to 65 per cent semolina, 12 to 15 per cent flour, and 20 per cent bran. The flour from such wheat is poor. Some of our durum wheats closely approach these figures. The milling of such wheat is modified to obtain a higher percentage of semolina than in the regular milling for flour. Furthermore, the semolina obtained from such wheat is superior to that from ordinary wheat for making paste with the result that practically all paste is now made from semolina from durum wheat.

Pastes are made by moistening the semolina with the minimum quantity of hot (near boiling) water necessary to convert it into a smooth, thick, tough dough. It is kneaded by machine since it requires considerable power and must be worked continuously for about 20 to 35 minutes, the time varying somewhat with the batch mixture and the strands to be made in the finished product. The mass is then placed in a power press capable of exerting a pressure of 2,500 pounds per square inch and the dough forced through openings in a platten which will give the size and style of product desired as macaroni and spaghetti in the form of hollow tubes; vermicelli in fine or coarse strings with smooth or fluted surfaces; flat ribbons; forms for alphabets, etc. Other common trade designations are spaghettini, forati, ziti, mostassioli, danatali, rigati, ditalini, ditali, spaghetti elbows, macaroni
elbows, farfalle, sea shells, daisies, small butterflies, stars, alphabets, melon seeds, cappelini, tagliarini, reginini, etc.

Noodles differ from regular paste in that egg is incorporated into the dough. In Italy beet juice, spinach juice, and other coloring is also added.

The use of warm water in the paste permits working the dough more easily and the finished product is not so tough. The holding of the water to the minimum shortens the time in drying and since the moisture must be reduced to 13 per cent and evaporation is slow this is an important consideration. The higher the water content, the greater the danger of souring if the drying be slow or of case hardening if it be rapid.

The strands from the press are cut into appropriate lengths, about six feet, to hang on racks to dry, or cut into pieces and placed on screens. The drying starts off fairly rapidly to give strength to the paste and to hold the form but as soon as this is accomplished the work is conducted more slowly so that the moisture will be removed from the interior of the dough as well as from the surface. Too rapid drying causes case hardening of the surface and a brittle flinty product, so that the operation requires the greatest care to get the desired results. Formerly the work was done out of doors, in open sheds, or even some of the moisture tempering was done in cellars, the whole operation requiring from two to three weeks. The modern method is to use dehydrators with perfect control of humidity, volume, and temperature of the air, the entire operation requiring 48 hours or less. All operations are conducted on as high standard of sanitation as found in the other food industries.

The finished product is hard, has a smooth surface, is of a light straw color with a more or less translucent effect. It breaks with a jagged irregular line. Foreign paste is frequently given a deeper yellow color by the use of saffron or other agent but the addition of any color is not permitted in this country.

The definition of macaroni under the regulations promulgated under the Food and Drugs Act is as follows:

Macaroni is the shaped and dried doughs prepared by adding water to one or more of the following: semolina, farina, wheat flour. It may contain added salt. In the finished product the moisture content does not exceed 13 per cent. Various shapes of macaroni are known under distinguishing names, such as spaghetti, vermicelli.

Semolina macaroni is macaroni in the preparation of which semolina is the sole farinaceous ingredient.

Farina macaroni is macaroni in the preparation of which farina is the sole farinaceous ingredient.

**Composition**

The composition of domestic and foreign paste is given by Wiley in Foods and Their Adulteration, as follows:

<table>
<thead>
<tr>
<th></th>
<th>Domestic</th>
<th>Foreign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>10.27</td>
<td>10.32</td>
</tr>
<tr>
<td>Fat or ether extract</td>
<td>.40</td>
<td>.35</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>.49</td>
<td>.53</td>
</tr>
<tr>
<td>Protein</td>
<td>11.61</td>
<td>12.29</td>
</tr>
<tr>
<td>Starch and sugar</td>
<td>76.52</td>
<td>76.10</td>
</tr>
</tbody>
</table>

The above is for the dry preparation and places it in the class of foods high in nutritive value and at the same time well balanced. It is higher in proteins and lower in starch than is flour.
A patent for a whole wheat macaroni was granted as late as April 8, 1919, to Marie Louise Bouchet, Roselle, New Jersey, and is No. 1,299,819. It contains the following:

The object of this invention is to produce macaroni or like food product of high nutritive value and which is extremely healthful.

In the manufacture of the new macaroni, the operator first takes wheat in the form as gathered from the plant, and without removing the bran, carefully cleans the wheat by any suitable means.

As soon as possible after cleaning, the wheat should be crushed or ground to a farina-like state—one in which the bran and also the gluten parts are converted into a homogeneous whole, and, as hereinafter stated, ground so fine that all the natural salts are easily soluble from the bran and are easily absorbed in the human alimentary canal.

Immediately the milling is completed, I add water (near to the boiling point) and also salt, or salted water, and this mixing continues from twenty minutes to one-half hour. In practice, the proportion of water to that of salt has been from fifty to one hundred parts of water to one part of salt. The salt apparently releases the ash and the fat contained in the bran. The product is of a golden brown color, and has greater strength and durability than the usual macaroni. It is cheap to manufacture, highly nutritious and apparently more healthful, in view of the belief now expressed by many eminent physicians and food specialists, that whole wheat, meaning all parts thereof, is more beneficial and more easily digested than the ordinary white flour resulting from grinding only a portion of the wheat.

What I claim is:

The process of preparing a whole-wheat macaroni consisting in mixing water and salt with finely ground whole wheat—the proportions being from one part of salt to fifty parts of water to one part of salt to one hundred parts of water—kneading the aforesaid mixture for not less than three-quarters of an hour, forming the dough into tubular bodies, and slowly drying the tubular bodies.

Preparation

The preparation of macaroni for the table and especially the making of the sauce requires more time and a wider variety of ingredients than is convenient in the small household. To meet this situation canners have used their art to supply the article ready to serve. A patent was taken out on an "Improvement in the processes for preparing and canning macaroni" while we were still dependent upon the imported product as a source of material. This was by James H. Irwin, New York, December 9, 1879, and is No. 222,404. The form of the title would seem to indicate that canning of macaroni had been done previously but no record has been found to that effect.

The provisions are as follows:

Put one pound of macaroni, broken into lengths not less than seven inches, into a mixture made of one gallon of water, two ounces of salt, and one-half pint of port wine, and boil twenty minutes, until the macaroni is properly swollen, but not broken. The object of the salt and wine and boiling, etc., is to flavor and as a preservative.

The preparation is now in condition to commence process of baking and canning. Take three pounds of macaroni, swollen by the process as before stated, and place it in a can. After placing in cans, three pounds in each can, pour into each canful of macaroni, as stated, about one gill to each pound of macaroni of a preparation composed of the following ingredients, and in the following proportions: tomatoes, previously boiled and strained to the consistency of jelly, twenty-five per cent; beef-stock, sixty-five per cent; ten per cent onions, previously boiled and strained to the consistency of jelly. Then add butter in the proportion of four ounces to three pounds of macaroni; then cover the whole contents of can with about one-fourth pound best Parmesan cheese; then moisten thoroughly with water; then place cans in an oven, into which steam is injected until contents, as heretofore prepared, are thoroughly browned; take out of oven, spread contents with about two-thirds of a tablespoonful of browned flour (as coloring matter) to each pound of preparation. When cool
solder up; then place the cans in a suitable pan in a steam-bath of at least 200° F.; let them so remain about twenty minutes.

It is intended to place the macaroni in cans containing three pounds of macaroni, in addition to the other ingredients, and the directions above given are with a view to that quantity; but the macaroni can be canned in any other sized can, the quantity of materials to be varied according to the size of the can.

Whatever may have been the results of using this formula at the time it was patented, it is obvious that subsequent experience would not approve a process at such a low temperature.

The following formula was published in “A Complete Course in Canning” for 1919 and is based upon a high-grade product then in use.

**ITALIAN STYLE SPAGHETTI WITH CHEESE AND TOMATO SAUCE**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spaghetti—High-grade, domestic</td>
<td>200 pounds</td>
</tr>
<tr>
<td>Cheese—English dairy variety, grated</td>
<td>40 pounds</td>
</tr>
<tr>
<td>Creamery butter</td>
<td>14 pounds</td>
</tr>
<tr>
<td>Whole tomato pulp, Sp. Gr. 1.035</td>
<td>50 gallons</td>
</tr>
<tr>
<td>Sugar</td>
<td>40 pounds</td>
</tr>
<tr>
<td>Salt</td>
<td>24 pounds</td>
</tr>
<tr>
<td>White pepper</td>
<td>½ pound</td>
</tr>
<tr>
<td>Paprika (optional)</td>
<td>½ pound</td>
</tr>
</tbody>
</table>

Boil the spaghetti for 20 minutes in 200 gallons water with 16 pounds of salt. Drain off and cool for 20 minutes. Make a smooth sauce of the remaining ingredients. Keep hot and agitated until all is used. Put about 7 ounces of spaghetti in a No. 2 can and fill with the sauce, process at 220° F. for one hour.

The average net weight should be ascertained and stated on the label. The statement “Heat the can in boiling water for 15 minutes before serving” should also appear on the label.

This trial formula may be clarified by the following explanation. Bring the salt and water to a boil in the kettle, break the spaghetti apart and distribute in small quantities over the surface until all is added, stir very gently during the boiling which should take from 15 to 25 minutes as found best by experiment. One of the objects is to keep the strands separate and prevent matting. On an average, 20 minutes will be found time enough to cause softening and swelling the strand equivalent to being about two-thirds cooked. Macaroni takes up about three times its weight of water and it is desirable that most of it be absorbed at this step.

The moment the batch is done, it is drawn off at once into a shallow tank and cooled with water or upon a rubber belt and sprayed to chill it. If filled hot into the can it mats or the strands stick together to a greater or less degree while if cooled it retains the identity of the strands. This is important in preserving a good appearance. The cans are filled by hand and the work can be done directly from the belt or at the filling table but the material must not be allowed to become dry. The fill must be by weight which depends upon the preliminary cooking and the amount of sauce wanted on the finished product.

Macaroni and spaghetti of themselves have little flavor, being nearly neutral and pasty. Their savor depends upon the dressing or sauce, hence the necessity for having one which not only is pleasing and stimulating to the taste but also attractive to the eye. It should be nearly liquid and yet adhere to the strands so as to be an intimate part of them, or in other words,
impart its qualities without being recognized as distinct from the macaroni. These requirements seem to be met in a sauce made from tomatoes seasoned with spices and cheese.

As a canning problem, the making of the sauce is more difficult than the preparation of the paste. Only tomato pulp of the highest quality is suitable for the purpose. The color needs to be as bright as can be obtained, since darkening to some extent occurs as a result of the high temperature used in sterilizing so that if the color be dull to start with, it will be even less attractive on the final product. Fresh red ripe tomatoes are ideal but not available at all times. The spicing may take on a wide range from the simple ingredients suggested in the formula through the variety in making ketchup. Onions and garlic in very limited amounts are almost invariably included in an Italian sauce and also a small quantity of sour wine but not vinegar. Finely grated Parmesan cheese is generally preferred, though a fully ripened cheddar cheese which has become a little dry and developed some sharpness also serves.

The ingredients for the sauce are placed in the kettle and boiled quickly, then run through the finishing machine to be used without holding any longer than is necessary. Some include a very small amount of starch or flour to act as a thickener if a test shows the need in order to cause the sauce to adhere to the strands. The filling of the sauce is always done by machine. One variation in saucing is to add the grated cheese separate on the top of the macaroni and then the balance of the sauce.

The development of a satisfactory distinctive sauce is a matter of many experiments on small lots until the right combination is attained.

Nearly all macaroni and spaghetti is canned in No. 1, No. 2 and No. 10 cans, the smaller for family use and the No. 10 for hotels and restaurants. The former are cooked at 240° F. for 40 minutes and the latter at the same temperature for 120 minutes. A better distribution of the sauce is obtained when the cans are turned on the side when cooking, also a better heat distribution throughout the can. Cooling should follow promptly after the cooking in order to retain the best appearance.

**Label Weights**

Spaghetti (Sp. Gr. 1.06). 8Z Short, 7 ozs.; 8Z Tall, 8½ ozs.; Picnic—No. 1 East, 10½ ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.; No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; No. 10, 6 lbs. 10 ozs.

**McGowan Patent**

A patent that has been issued for the canning of spaghetti and similar foods is of interest. It is No. 1,634,332, July 5, 1927, and issued to James McGowan, Jr., Mechanicsville, New Jersey. The following is quoted:

Heretofore, as I am advised, in canning spaghetti and similar foods, the spaghetti has always been cooked in open receptacles, as in pots or kettles, in a suitable quantity of water. When the spaghetti has been fully or completely cooked, it is taken from the receptacle, washed in clean water, cooled, and placed in a pile or mass on a suitable table. From this pile or mass small quantities (handfuls) are usually manually separated from the pile or mass of cooked spaghetti, then weighed and then placed in the cans or containers. In some instances the cans may be put on a weighing machine and enough cooked spaghetti may then be placed in the can, to bring the weight of the contents and can up to a predetermined point. After the proper weight of cooked spaghetti
has been placed in the can, a cooked sauce, which includes fats, such as butter or cheese, and may contain tomatoes, is also put in the cans with the spaghetti. The can is then hermetically sealed, then sterilized and cooled. It is then ready for delivery or shipment.

In cooking spaghetti in the manner above described, great difficulty is experienced in obtaining a uniform product. Too much cooking (over-cooking) or cooking at too high a temperature changes the character of the product. While the temperature to which the spaghetti is subjected during the cooking step may be fairly well controlled, the other factor, over-cooking, presents a more difficult problem since it depends on the opinion of the cook, and because delays are often met with in weighing the cooked spaghetti and putting it into cans. A second batch or quantity of spaghetti may be cooked before all the previous batch has been put into cans and it may therefore become necessary to allow the second batch or lot to remain subjected to a cooking temperature a little too long, or remain too long in the presence of water.

It is one of the objects of my invention to remove these factors which vary the character of the product, by placing the spaghetti, while dry, in the cans, adding the sauce, hermetically sealing the cans, then subjecting the contents of each can to the same cooking temperature and for the same length of time. This object is readily accomplished by the practice of my method described below because I eliminate the step of transferring cooked spaghetti to cans, and the possibility of delay of transferring to the cans the second batch or quantity of cooked spaghetti.

In practicing the old processes or methods above outlined, substantial differences in the finished product contained in different cans are readily observable, although the spaghetti in such cans may have been taken from the same mass or pile on the table, for as long as, and throughout the time that the spaghetti stands in the pile, after it has been washed, and on the table or tray before it is put in cans, it will continue to absorb water, so that the spaghetti which was last taken from the heap or pile will contain more moisture or water than that earlier removed from the same pile. For that reason the contents of various cans from the same pile or source or lot will vary in the water content.

Moreover, as the moisture is thus being absorbed by the spaghetti while it is in a mass or pile on the table, it is cooling and the stickiness or tackiness of the spaghetti is ever increasing. To prevent the strands of cooling spaghetti from sticking together and from clinging to her hands, in transferring it from the table to the can, and to the weighing machine, the operator frequently sprinkles the pile with clean water, for that prevents it from sticking to her hand and the scales, for wet spaghetti does not readily adhere to a wet surface. So long as the flour paste, formed in cooking the spaghetti, is thin and fluid it is slippery.

But this very manipulation of the spaghetti in putting it into the cans adds water to the pile and variably increases the amount of water which is constantly being absorbed by the pile or mass of spaghetti on the table, causing the contents of different cans to substantially vary from each other. The last quantity placed in the cans or tins from the same batch or pile will thus contain still more water than the first transferred to the cans, for the water sprinkled by the operator over the spaghetti is unevenly absorbed by the different strands in the pile of spaghetti. In the process as hereby practised, in canning spaghetti, these factors produce substantial variations in the contents of the different tins or cans, although the spaghetti may have been from the same lot or batch.

It is the object, therefore, of the present invention to obtain a uniformity hitherto unattainable in the quality of the canned product whether it be taken from the same or different batches; to obviate and dispense with all manual treatments or transfers of cooked spaghetti; to shorten the time for the thorough cooking of the spaghetti; to prevent contacting strands or lengths of spaghetti from sticking or adhering to each other; and to keep each strand intact and entire and free from attachment to the other strands in the can or tin.

Other objects of my invention will appear in the specifications and claims below.

In carrying out my invention, I take one or more samples of dry spaghetti from a batch or quantity of the same and carefully test such samples, particularly as to the amount of water that will be absorbed by the spaghetti in properly cooking it. Each batch or lot of dry spaghetti to be cooked is so tested before cooking it.

The proper weight of dry spaghetti is then put into the tins, cans or other containers in which they are to be placed on the market, together with a definite quantity of hot
APPERTIZING

water, as determined by the tests above referred to, and also with a certain and definite amount of hot partly cooked sauce therefor and other seasoning or condiments desired. The amount of water placed in the can, including that in the sauce, is that which has been determined for that particular batch or lot of dry spaghetti and is exactly the same amount in each can for that lot. After the dry spaghetti, water, sauce and other seasoning have been thus placed in the tins or cans, the cans are hermetically sealed and in that condition are immediately transferred to a suitable heater, cooker or oven where the contents of the cans are cooked for a definite length of time, as for instance, an hour.

The step of cooking per se may be carried out in several ways. The temperature of the oven may be merely a cooking temperature and the cans may be allowed to remain in the oven for a time sufficient to thoroughly cook the spaghetti and to complete the cooking of the sauce, after which the sealed containers may be transferred to a suitable sterilizer where they are subjected to a relatively intense heat for the short time required to insure the sterilization or destruction of any living organisms therein.

Or the cans may be subjected to a single heating at a higher temperature than has been above referred to as cooking temperature and to effect both the cooking and the sterilization in a single operation, or after the heat of the cooking oven has been maintained long enough to effect the cooking of the contents of the cans contained therein, the temperature of the oven may be raised to a point sufficient to accomplish the step of sterilization.

These three modes of treatment are fully within the aim and scope of my invention. But whatever process of this cooking and sterilizing spaghetti in hermetically sealed containers be employed, it is essential to my invention that the spaghetti in the cans be subjected to agitation, motion or shaking while the contents are being cooked. Spaghetti in the presence of hot water becomes gummy or sticky and if the strands are not frequently moved so that they will slide with respect to each other, they will adhere to each other and settle down to the bottom of the can as a sticky, soggy mass of paste. If, however, the cans are substantially continuously agitated or shaken or rolled during the cooking process, or so frequently as to cause the strands of spaghetti to move and slip and slide over each other, while cooking, before the paste has time to thicken sufficient to cause the strands to stick together, the identity or unity of the strands will be kept unimpaired, and the strands will remain separate and unattached to each other after the spaghetti has been cooked.

The cans or containers may be subjected to agitation during the step of sterilization which follows the cooking step but if the agitation be maintained until the spaghetti is completely cooked, it may be omitted during the sterilization process. It is essential, however, that the cans be subjected to such agitation or motion that the strands of spaghetti are kept continuously moving or frequently moving over each other throughout the step of cooking.

In the practice of my invention, the spaghetti is preferably kept in constant agitation, but it is possible to carry out my improved process by effecting an intermittent agitation of the spaghetti providing the interval of rest between periods of agitation or motion be brief and not long enough to permit the strands to stick together. For practical purposes such an intermittent operation I regard as a substantial continuous agitation and fully within the aim and scope of my invention.

In carrying out my invention as above described, the agitation of the contents of the cans or containers may be effected in a variety of different ways. In the handling and treating of foods in containers, many carriers, which convey the cans to and through various machines or mechanisms or from one machine to another, subject the cans to a substantial agitating, shaking or rolling, and any such machines so operating are suitable for imparting to the spaghetti in the cans, during the cooking operations, a movement of agitation sufficient to prevent the adherence of the independent strands of spaghetti in the cans to each other, and to prevent the formation of a pasty mass in the bottom of the can. Any such suitable agitating means may be installed in the oven or cooking apparatus and arranged to traverse the cooking apparatus in a predetermined time to agitate or shake the cans during the cooking operation to prevent the strands from adhering to each other.

The adherence of the strands of spaghetti to each other is due to the fact that spaghetti is composed practically entirely of dried flour and, in cooking it, a flour paste forms on the surface of the strands of spaghetti. If, during the cooking of the contents of the sealed cans, the cans are not agitated or shaken this flour paste on the strands of spaghetti causes them to adhere to each other, and a pasty gluey mass also
forms at the bottom or lowest part of the can or container. When so shaken or agitated, however, the pasty film on the outside of the strands does not have time to set for the pasty film on the strands is being constantly diluted or thinned by the water of the sauce and kept in a fluid condition and the strands will slip over each other. The pasty film forming on the strand is to a certain extent scraped or rubbed off by the passage thereover by the other strands and the paste is kept in a fluid, slippery condition. In this way then are the strands kept intact and separate one from the other and the cooking is perfectly effected.

Moreover, the agitation of the strands or pieces during the cooking operation shortens the time required for the cooking step and also imparts a finer color to the finished product when a sauce, such as tomato sauce, forms a part of the contents. The color, for instance, of tomatoes, is soluble in the fats contained in the sauce. When the containers are agitated the color is evenly distributed throughout the sauce, imparting to the sauce a much brighter color than is obtained by the practice of the old processes. Moreover, the agitation of the sauce causes more of the flour to be separated from the strands with the result that the sauce becomes thicker than that produced in other ways except perhaps where flour or starch is an ingredient of the sauce and the color is evenly distributed throughout this thicker sauce. When a can is opened, therefore, the contents present a better appearance, both as to color and texture of the sauce than when the spaghetti is cooked in the manner heretofore practised.

I am aware that it has heretofore been proposed to cook certain food products in cans hermetically sealed and that, during such process of cooking, the cans have been rolled through the oven or other heating apparatus for the purpose of preventing the contents from sticking to the tin and burning, such process being exemplified in U. S. Letters Patent No. 1,365,928, dated January 18, 1921, but the main object of such rolling of the cans, as set forth in said patent, is to prevent the contents from sticking to the interior of the cans and consequently discoloring of the product. This consideration, however, has little applicability to my improved process. The products which I cook in sealed containers, have entirely different qualities or properties, for in cooking, the pieces of spaghetti would melt down, as it were, and form a real paste which causes the pieces to adhere to each other and stick and form a pasty gummy mass at the bottom of the can if the cans were not agitated.

The purpose of the rolling step of the said patent is to prevent the contents from burning on to the inside of the tin, or in other words, to prevent the contents from remaining on the same spot on the tin. In my process the agitation is to keep the contents slipping and sliding over each other so that the paste on the strands does not have time to set and glue the strands to each other or to separate from the strands and settle at the lowest part of the can as flour paste. My invention is, therefore, clearly distinguished from that disclosed in the above patent since the purpose and function of the agitation is for an entirely different purpose, due to the nature of the material being cooked, and is not particularly for the purpose of preventing the contents sticking to the inside of the tin and burning.

It is to be understood that my improved process above described is particularly adapted to the cooking and canning of such foods as spaghetti, macaroni, vermicelli, noodles and such other similar glutinous foods as tend in cooking to forming a pasty or gluey mass in the presence of hot water, and I have used the word “spaghetti” to typify all such glutinous foods, the separate pieces of which, by being kept substantially constantly in motion, slipping over each other during the cooking of the same, are maintained entire, free and unattached to the other pieces of the same in the containers or tins.
SIRUP AND MOLASSES

Sirup and molasses are terms which were formerly used interchangeably as maple sirup and maple molasses, sorghum sirup and sorghum molasses, and the same applied to cane though to a lesser extent. In many of the older works upon cookery, the terms are used as if they were synonymous but present usage differentiates them. A sirup is the product resulting from the evaporation of the juice from a sugar producing plant without removing any of the sugar or by the dissolving of sugar, or concrete to the consistency of sirup, while molasses is the product left after separating the crystallizable sugar from the juice which has been evaporated to a solid or semisolid state. The one is the direct product of the concentration of all the sugar in the juice with sufficient associated matter to give it a distinctive character, the other is the by-product of sugar-making and consists chiefly of noncrystallizable sugars and other matters which impart flavor. Sucrose is the dominant sugar in cane, maple, and sorghum sirups.

Corn sirup is a different type of product, obtained by the chemical action of a dilute acid upon starch from corn and differs in no respect from that obtained from other starches when treated in like manner. Dextrose is the dominant sugar. The two types of products are mixed in many of the commercial preparations upon the market.

The manufacture of cane sirup naturally dates back to the earliest use of cane juice as a food and cane molasses from the beginning of the manufacture of sugar. Both cane and maple sirups were made since the earliest settlement in this country and up to the middle of the last century were relatively of much more importance than at present. Sorghum sirup was little known prior to 1870, but about that time an endeavor was made to have it replace some of the cane sirup since it was found that the sorghum plant could be grown here. The result is that the two sirups are about on a par in point of production. Glucose, or corn sirup as it is known here, is of Russian origin and German development, but during the seventy years of manufacture in this country has increased until it represents more than 50 per cent of the total sirups consumed.

The quantity of sirup produced in the United States, as given in “Sugar-cane Sirup Manufacture,” Bull. 1370, U. S. Department of Agriculture, and the Yearbook for 1934, is as follows:

<table>
<thead>
<tr>
<th>Type of Sirup</th>
<th>1919</th>
<th>1934</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar-cane sirup</td>
<td>38,183,000 gals</td>
<td>19,106,000 gals</td>
</tr>
<tr>
<td>Cane molasses (edible)</td>
<td>6,706,000 gals</td>
<td>8,067,000 gals</td>
</tr>
<tr>
<td>Refiners’ sirup</td>
<td></td>
<td>3,692,000 gals</td>
</tr>
<tr>
<td>Sorgo sirup</td>
<td>39,413,000 gals</td>
<td>14,961,000 gals</td>
</tr>
<tr>
<td>Maple sirup</td>
<td>3,885,000 gals</td>
<td>2,175,000 gals</td>
</tr>
<tr>
<td>Maple sugar sirup</td>
<td>684,000 gals</td>
<td></td>
</tr>
<tr>
<td>Corn sirup</td>
<td>81,800,000 gals</td>
<td>781,000,000 lbs</td>
</tr>
<tr>
<td>Corn sirup (mixed with other sirups)</td>
<td>199,051,000 gals</td>
<td></td>
</tr>
</tbody>
</table>

Formerly the distribution of sirup and molasses to retailers was in hogsheads, barrels, and kegs to be drawn off into the customer’s jug, bottle, or jar. As in the case of other foods, the packaging has changed to the more sanitary and convenient individual type, tin and glass containers. The chief exceptions to these are for the large users, as confectioners and bakers.

Sugar-cane sirup was probably known since early in the Christian Era and obtained by the evaporation of the juice expressed from certain tropi-
cal grasses, notably the sugar cane. It was used first for its sweet flavor, then highly esteemed as a medicinal agent, but it was not until about the fourteenth century that it became recognized as an important food product. Used as a substitute for honey in the fifteenth century, it gained such a place in commerce that immediately after the discovery made by Columbus, the Spanish introduced the sugar cane into the West Indies under the belief that it would be a source of great profit. The first planting was made in San Domingo in 1494 and in Florida a few years later, but not in Louisiana until 1751. In the nearly four and a half centuries, the value of the sugar produced represents more wealth than the Spaniards ever dreamed existed.

As far as the general public is concerned, sugar is the only direct product of the sugar cane and outside the area in which cane is grown the sirup and molasses are thought of as by-products. The facts are that thousands of acres of land in the Gulf area have been from the earliest settlement and still are given over to cane production for sirup as the primary product. This sirup is held in the same esteem as a table sweet in that section as maple sirup is in the northeast. It has one decided advantage in that it can be produced in any amount desired while maple sirup is limited by nature. It is of further interest that of the large production of sugar-cane sirup, by far the greater portion is consumed where it is made.

**Sugar-cane Sirup**

Sugar-cane sirup made in an open kettle or evaporator has a quality very different from the sirup made at the sugar mills in vacuum pans. To begin with, the small mills rarely ever have the power or equipment to extract all the juice, but as a rule obtain only from 55 to 60 per cent of the total weight as juice. The lack of efficiency in this respect has its compensations in that only the part with the most agreeable flavor is obtained. Little attention is given to clarification other than to skim well while boiling, thus leaving the native plant qualities, often incorrectly designated as impurities, to give it distinctive character.

Sugar-cane sirup manufactured in the country and on plantations by small scale methods is a variable product due to the character of the soil upon which the cane is grown, the method of cultivation, the variety of cane used, the stage of maturity when harvested, the length of time of holding after cutting, the pressure used in pressing, whether the juice be boiled in a batch in a kettle or concentrated by a continuous process in an evaporator, the thoroughness of the skimming, and the means used in clarification. This lack of uniformity has been a hindrance to commercial success and is overcome in part only by the producers consigning their offerings to large concerns for blending, standardizing for sugar content, treating to remove excess color, etc.

Sugar cane grown for sirup is usually cultivated in small patches of from one to five or ten acres, the several farmers in a community taking their crop to one mill for grinding and evaporating. This is shown by the fact that there are several hundred mills producing sirup, whereas only a few are engaged in the manufacture of sugar, each of the latter using the crop from several hundred acres.

There are about ten varieties of sugar cane grown especially for sirup and of these Ribbon cane seems to be the favorite. It is smaller, hardier, and better adapted to growing under varying conditions than that raised
especially for sugar. It has a native flavor in addition to sweetness which makes it valuable for sirup. The cane best suited for sirup is grown upon good soil, preferably of a clayey loam type not too dark in color, and with a fair amount of moisture. The black alluvial soils are best for tonnage amount of sugar obtained, but produce a dark colored sirup somewhat deficient in flavor. The lighter soils produce from 8 to 14 tons of stalks per acre while the black lands may yield 20 tons or more. Cane fields are prepared very much like those for corn but instead of planting seed in rows, stalks from the previous year are cut between the nodes and planted. The plant requires much cultivation so that it is costly to bring to maturity.

The harvesting is done in two stages, breaking down the leaves or stripping, and cutting the stalks close to the ground. The canes are loaded on wagons like cordwood so that the maximum amount may be handled at one time, though slings are also spread while loading so that the unloading may be done quickly and with the minimum of labor, as the slings are lifted by a hand hoist or a small power lift with block and boom. The small plants generally have a capacity of ten tons per day, which is the equivalent of the product from one acre, requiring two teams to harvest and haul.

The harvesting period usually lasts from 45 to 80 days or from the middle of October until into December, though it would probably be more nearly correct to figure from 35 to 50 days in any one locality. The season is well advanced in Georgia, Alabama, and Mississippi before it starts in Florida, southern Louisiana, and Texas.

The equipment used in making sugar cane sirup varies from the simple three-roll grinder and flat evaporation pan to the latest complex sugar factory type in which are used multiple rolls, power, highly technical clarification treatment, and multiple effect vacuum pan. Historically the equipment was even simpler, a two wooden roll grinder with a sweep to which a mule was hitched to supply the motive power by walking in a circle. The evaporator of the same period consisted of a cast-iron kettle suspended from a pole in the open or there might be two or three, set in masonry. A few tubs and barrels to hold juice and the finished product completed the inventory.

**Georgia Method**

The simplest method and equipment used at present, generally known as the Georgia method, constitutes by far the largest number of outfits, does little more than increase the efficiency of the former by making the grinder stronger, supplanting the deep kettle by a shallow evaporator of thin metal to obtain more heating surface, and adding such conveniences as tend to minimize labor.

The typical grinder is the three-roll iron mill, the opening on the feed side being three-eighths or one-half inch and at the finishing side, one-sixteenth of an inch. The rolls may work vertically or horizontally and the feeding be done by hand or from a belt, the bagasse being carried off and delivered on a wagon or dropped on a pile. Owing to the fermentation which is sure to follow, the better practice is to haul the refuse away from the vicinity of the plant at once. In very many places the power is still furnished by mules, though a gas or steam engine or electric motor is preferable so as to eliminate the dust made by the animals and the droppings which attract flies.
The raw juice is filtered through coarse cloth as it leaves the mill in order to remove bits of tissue and particles of dirt which enter as a result of crushing. The juice is collected in tanks about four feet in height and from two to three feet in diameter, the three foot being preferred, so that each batch of juice can settle for two hours or more, one tank being filled while another is being drawn off. It is a convenience to mark the tanks at different levels to show the number of gallons as 50, 100, and 150 in order to standardize the batches. This also aids if milk of lime be added as a clarifier.

The lime is slaked and made into a heavy paste and kept in barrels. The proper amount for clarifying a batch of 100 gallons of juice, and from that the proportionate amount for the other divisions on the tank, is determined on a few test batches at the start, care being taken that the juice remain acid and not become neutral or alkaline as either condition causes some injury to the sirup and darkening. A simple test is made first by using half a pint of the lime paste rubbed thin in some water to 100 gallons of juice and noting the reaction on litmus paper. If the juice be acid, blue litmus paper turns red on being wet with it and red litmus paper remains unchanged. If the juice be made alkaline, the red litmus paper turns blue. The lime is increased if need be to reach the neutral point, or if the first portion was in excess, juice is added until neutral. In practice the aim is to use about three-fourths the amount of lime necessary to neutralize the batch. Thereafter the proper quantity of lime paste is rubbed up in water to make it thin and smooth and then added to the juice and vigorously stirred to insure uniform distribution. The real function of the lime is to mix with the material coagulated in the subsequent heating so as to make removal by skimming more nearly complete. The juice is drawn off to about four inches above the bottom of the tank, the lower portion kept separate and refiltered before adding it to a subsequent batch.

The lime treatment is not an essential, only a convenience in speeding up the time for settling and lessening the waste in skimming. Clay was formerly used with lime or as a substitute for lime but this introduced foreign dirt which could not be wholly recovered, and besides is objectionable. The neutralizing effect of the lime has a beneficial effect upon the flavor.

The yield of juice per ton of stalks for the smaller mills is figured on the basis of 60 per cent of the weight of the stalks, or 1,200 pounds per ton, which is higher than the average obtained in operation. On this basis a 10-ton mill will have a capacity of 12,000 pounds of juice per day.

The juice naturally contains some soluble solids other than sugar but the proportion is so small that the total solids are expressed in degrees Brix or Baume. The former scale is preferable as it is very close to the percentage of sugar present, while the latter is merely an old custom and is inconvenient in that it requires consulting a table of equivalents or making a calculation to get an adequate idea of the sugar content of the juice. The ordinary range for juice is from 14 to 16° Brix, though it may run higher or lower depending upon the condition of the stalks when cut, variety, season, etc., but the average is not far from 15 per cent, which is accepted as a representative figure for making estimates. In order to make sirup, the juice must be concentrated so it tests between 71° and 72° Brix at the standard temperature 60° F., or better still for canning at 73.5° Brix. This makes the ratio nearly five parts of raw juice to one of the finished
sirup, which is further widened by losses in skimming as clearly evident in practice, since one ton of cane yielding 1,200 pounds of juice will produce but 20 gallons of sirup weighing 11.25 pounds per gallon, making the ratio 5.3 to 1.

The earliest evaporating devices, an iron kettle hung on a pole over a fire or large shallow kettles mounted in a masonry furnace have become obsolete for the production of commercial sirup, their places being taken by either the direct heated evaporating pan, the open steam heated pan, or the vacuum pan. The advantages of the older type were that it was extremely simple, could be used at any place, and wood of almost any character employed as fuel. The disadvantages were the long time required to reduce a batch, generally from three and one-half to five hours; inability to do a good job of skimming due to the volume; more or less burning of the sirup on the kettle during the last quarter of the boiling; darkening of the sirup from prolonged heating, and deterioration of flavor as a result of over-heating and attack of the juice upon the metal.

The type of evaporator in common use is the open shallow pan first brought out about 1825. This is generally about 12 to 15 feet in length, 3 feet in width, and 6 inches in depth, mounted over a brick firebox. Other sizes are available but this one has proven desirable for economy in construction, uniform heat distribution, and convenience in operation. The pan is usually made of copper or galvanized iron and has a series of incomplete cross partitions that act as baffles to cause the juice to travel back and forth from one side to the other in passing from the feed end to the discharge end of the pan. The pan is set on a slight incline so that the receiving end will be lower than that for the overflow, the depth of the juice in the former being about 2.5 inches and in the latter about 1 inch. It is immaterial in which direction the pitch is made, though the majority are set to receive the juice directly over the firedoor. The settled and filtered juice is permitted to enter at such volume as to be practically reduced to sirup when it reaches the overflow and thus the operation becomes continuous. As with the kettle, the skimming must be done by hand but, since the juice is in a thin layer, the separation is better and there is less “cooked in.” Most of the skimming is done in the first third of the pan. Some of the more expert sirup makers select a 15- in preference to a 12-foot pan and permit little fire to strike the first two or three feet. This favors the gradual heating of the juice as it runs in, which in turn favors the formation of a more tenacious scum that can be removed by skimming.

There is a wide range in these pans. The very cheap ones are made of galvanized iron and heated directly over the fire. One of the objections to this type is that the juice attacks the metal and soon exposes the iron with resulting injury to flavor and color. The better pans are made of copper and may or may not be tinned. The advantages of the pans are low cost, gradual heating of the juice which favors clarification, ease of skimming, rapid evaporation, short boiling period for any part of the juice, and continuous operation.

Operation is started by first covering the bottom of the evaporator with sufficient water to prevent any damage due to the direct heat. As soon as the water begins to boil, juice is drawn in at a slightly greater rate than that of evaporation. The sirup travels slowly from the filling end, causing the separation of a large amount of scum which is skimmed off and then
producing more and more vapor as it progresses with a gradual rise in temperature. The temperature at which the sirup boils corresponds to the concentration, thus making it a particularly convenient method of checking the finish. The temperature for finishing in the entire cane belt is between 223° and 224° F. A thermometer with a large bulb protected by a guard is suspended in the evaporator at the point of overflow so that it can be read at any time. The operator can hold back the sirup at the overflow until it reaches the proper temperature and adjust the inflow cock to obtain a continuous effect. After a few trials the regulation of the two valves becomes easy. An occasional check on the sirup is made with a Brix spindle.

The overflow passes through a fine wire screen into a receiving tank where it is held until a sufficient quantity accumulates to fill the desired lot of cans. The best temperature for filling No. 10 cans is about 160° F., but for smaller sizes it may be higher. Even 160° causes considerable collapse of the No. 10 cans but since this size is used by large manufacturers who understand the cause, there is little criticism. If the time required to accumulate a batch of sirup be more than an hour, and it usually is in small plants, it is best to cool the sirup by running it through a jacketed pipe or over a milk cooler, as it prevents darkening and cooked flavor.

Sirup made from clean cane, handled promptly from the cutting and through the factory, ground with sufficient pressure to extract not more than 60 per cent of the juice may be canned directly with little trouble other than possible separation of sugar crystals in the sirup. With some of the varieties of cane yielding appreciable quantities of invert sugar even this difficulty is eliminated. The cans are filled at about 160° F., sealed, and preferably given a short heating, 10 minutes at 185° F. as a measure of safety against infection from the final handling and the container. After the hot sirup has stood in the cans for about 30 minutes, it is best that they be cooled to nearly atmospheric temperature. Owing to the nature of the product it holds heat for a long time so that cooling serves to retain the maximum of natural flavor and also prevents springers. The type of springer occurring in this product differs from that in other food lines and is ascribed to chemical changes within the sirup itself favored by prolonged retention of heat.

The cans used are plain tin and are of the sizes indicated at the close of the section. Friction top cans are used as well as hermetic seals but the preference is for the latter if the product be shipped.

Bottles and glass jugs of pint and quart sizes are excellent containers and are handled in the same manner as cans except that the filling is usually done at about 140° F. with sufficient time allowed in sterilizing to bring the contents to 165° F.

Small unit plants of the kind described handle the product from about 40 to 50 acres during the season. They require little room, apparatus, or labor to operate. A building about 25 by 60 feet, a 10-ton three-roll mill, 5-horsepower gasoline engine or electric motor, a 15-foot evaporator, and the usual accessories of tanks, dippers, skimmers, thermometers, etc., with four men needed to feed the grinder, tend the evaporator, and do the general work.
Larger Production Units

Small production plants produce the quality of sirup most satisfactory to those who grow cane and are familiar with the natural sirup but such plants are expensive in labor and fuel when measured by standards of volume production. The difference in cost is met in part by the fact that the work is done in rural districts where wages are low and fuel easily obtained. To meet larger volume requirements, special equipment has been designed with the idea of retaining approximately the same quality in the sirup when working on a larger scale. Some technical control is required for these larger plants, whereas those handling from 10 to 30 tons of stalks per day depend upon an experienced operator and such simple tests as he may use. The larger plants utilize the cane more completely and depend upon standardizing the product to get a more uniform quality. The method and outfit is frequently called the "Louisiana way."

A heavier grinder is used and more pressure applied in order to increase the yield of juice. The result is some deterioration in flavor, particularly when it exceeds 60 per cent of the total weight. The hard pressing also increases the acidity which is undesirable even though it can be neutralized by chemical agents. One must therefore choose between quality and quantity and it is better in the long run to be governed by the former.

Instead of the juice being collected in tanks and allowed to settle, it is strained and at once subjected to the action of sulfur dioxide. An old but effective method is to use a small tower with numerous baffles inside over which the juice is made to flow from the top to the bottom. This insures a thin layer of juice with a very large surface exposure. Fumes from burning sulfur enter the tower near the bottom and as they pass upward, come in contact with the juice and are partially absorbed. The object is to have the total acidity of the treated juice, that is, the acidity normal to the juice plus that absorbed from the gas not to exceed the amount required to neutralize 3.5 cubic centimeters of a one-tenth normal alkali solution in a 10 cubic centimeter sample. Phenolphthalein is the indicator used. If the juice be too low in acidity, it can be run through the tower a second time; if too high, it can be diluted with untreated juice. Too much sulfur gives a sharp unnatural flavor which is objectionable. The testing for acidity is easily learned though the practical application should be acquired by a demonstration from a competent person.

Instead of the tower, the sulfur dioxide may be obtained in cylinders and introduced into the juice through a pipe distributor which at the same time agitates the mass and insures a uniform diffusion.

Immediately after sulfuring, the contents of the tank are treated with strained milk of lime prepared from slaked lime as previously described. The amount must be below that necessary for neutralization, and experience has taught that it is best to keep the acidity at about that necessary for 1.5 cubic centimeters of one-tenth normal alkali solution to neutralize a 10 cubic centimeter sample. The control must be very close to get the proper results and is obtained only by testing and measuring the volume of milk of lime to a definite batch in a tank. The juice is well agitated, then heated by a coil to near the boiling point, skimmed, and after about five minutes the operation repeated. If necessary, a third heating and skimming may be given though ordinarily two suffice. If the juice be made
alkaline, it is injured and can only be partly restored by adding unlimed juice to return it to the acid side. The treated juice is allowed to stand in the clarifier tank for an hour, is then drawn off from about three inches above the bottom, after which the portion below is drawn off and filtered before returning it to a subsequent batch. The sulfur dioxide decolorizes the juice and produces a brighter and more brilliant product, more attractive to the eye though not equally satisfactory to the palate. The lime precipitates the gums and other non-sugar solids making skimming and settling more effective and requiring less time. The combined result is a juice which can be worked through the evaporator more rapidly and produce a better appearing finished product. The decolorizing effect is not permanent.

Evaporators similar to those employed in the smaller operations may be used, particularly for plants operating at from 25 to 50 tons per day, but steam evaporators have so many advantages that they are used in all large plants and are being installed in all new factories and in replacements in old ones. They are built with long narrow boiling tanks about one foot in depth in order to cover the steam coils and provide for active movement of the juice in boiling. The evaporating tank and coils are of copper, the latter in sections to insure better heat regulation. The simplest type is usually built in two sections, the first for skimming and reducing the juice to the consistence of a semi-sirup (35° to 45° Brix), the second for finishing. The first section is the larger and has a skimming trough along each side so that when the juice is boiling the roll throws the scum into the trough and thereby eliminates most of the hand labor. The steam coils are so arranged on the bottom as to aid in getting proper roll to the juice. Baffles may or may not be used but in the event they are, it is most often in the smaller type of evaporator where they are placed lengthwise instead of crosswise as in the direct-fired pans. The juice enters one end and is discharged as semi-sirup into the finishing pan or it may be discharged into tanks remaining six or eight hours for settling. In the violent boiling produced in this first stage, additional fine flocculent material is formed which is allowed to settle so as to get a clear and high grade of table sirup. The clear portion is drawn off and finished at 61° to 62° Brix when it is ready for canning or packing in glass containers.

The vacuum pan may be used for the evaporation of the clarified juice following the same procedure of reduction to semi-sirup and then settling. The clarified semi-sirup is reduced at a low vacuum and is generally done at a sugar factory where such pans are part of the regular installation, and done only when the price of sirup is more favorable than sugar. Vacuum pan sirup is not considered equal to that produced in the open evaporator.

While the foregoing covers the principles of manufacture as developed and generally practiced, there are certain modifications and additional steps being taken by large operators and blenders.

Filtration

The first is the use of infusorial earth as a mechanical aid in the filtration of the juice. Experiments along this line were carried out at the Louisiana Experiment Station in 1919. The juice, whether raw or boiled, contains so much gummy substance and exceedingly fine flocculent material coagulated by heating that it will not pass through a filter. The addi-
tion of the diatomaceous earth entrains these materials and, bringing many particles together, increases the size thus producing a condition which permits their detention by a pressure-plate filter and at the same time allows the liquid to pass.

The procedure is to make the addition of from one to one and one-half pounds of the fine earth to a hundred pounds of the juice in the collecting tank, thoroughly mixing, and then vigorously boiling for five minutes. The hot juice is pumped immediately through the filter as the operation is more rapid while hot. The entire effect is mechanical, the juice not being altered in its composition as when chemicals are used. The juice comes from the press free from suspended matter and is ready for reduction to sirup. If the final sirup shows any cloudiness, the batch may be allowed to settle for several days before bottling or canning. This is the most practical method for removing any remaining traces.

The method requires the installation of a plate-filter press and a steam plant so that the economy of installation is doubtful where the output is less than 600 gallons per day, unless the manufacturer specializes in a particularly fine product.

Decolorizing

In order to obtain approximate uniformity in different lots of sirup, or a light color, the juice or semi-sirup is treated with a specially prepared vegetable carbon, known as activated carbon or by various trade names. The carbon is added to the juice after the usual clarification by lime or to the semi-sirup when it is settling and is removed later by filtration through the usual plate press. The amount of carbon is ordinarily between 1 and 1 ½ per cent, depending upon the depth of the color in the raw material or the lightness desired in the finished product. This process is used more particularly in standardizing small lots obtained from country mills to make them more merchandizable and in preparing sirup to be sold in certain sections of the country where a light appearance is preferred. In addition to affecting the color, it modifies the odor and mollifies the flavor, bringing a juice sirup one step nearer to a sugar sirup.

Preventing Crystallization

The latest control operation added to sirup-making is the prevention of crystallization of the sugar. A saturated solution of sucrose tends to form crystals in time. These are small and at first are like fine grains of sand but may grow to considerable size. Their occurrence in commercial sirup is looked upon as a manufacturing fault. Various means have been used to overcome the difficulty, the most successful being that of adding a very small quantity of invertase to the semi-sirup thus converting some sucrose to invert sugar, which effectually checks the tendency toward crystal formation. Invertase is an enzyme, commercially prepared from yeast, which is so active that only a small quantity is needed to effect the desired result without other appreciable effect upon the sirup.

The semi-sirup is run into a tank and cooled to between 140° and 145° F., then the invertase added at the rate of one and one-half to two ounces to the hundred gallons of sirup. The invertase is first added to a half gallon of water and then to the batch with much stirring to be certain that it is well distributed. A cover is placed over the tank to hold the heat and allow
the batch to stand for twelve hours or more. The temperature must not exceed 145° F., otherwise the activity of the invertase is destroyed.

The final finishing of the sirup and canning is the same as for the regular sirup.

**Molasses and Refiners' Sirup**

The by-products obtained in the manufacture of cane sugar belong in the same category as sirup since they are used both straight and in blending with sirups. Cane molasses is the product which clings to the crystals of raw sugar, known as massecuite, melada, mush sugar, or concrete. It has also been known as drips. It is washed out of the sugar at the beginning of the refining and concentrated to a thick heavy body, which is dark, usually of a decidedly yellowish color, has a flavor which differs from both sugar-cane sirup and sugar sirup, and is used in cooking, baking, and confectionery.

Refiners' sirup or treacle is the edible portion of the sirup remaining after separation of the crystallizable sugar in refining. It has a very dark color and a strong taste. Blackstrap is the inedible portion of the residue.

Sugar sirup is the sirup made by dissolving sugar in water at the rate of 65 per cent of the former.

**Canning**

The equipment needed for canning or bottling sirup is of the simplest kind. In the small plants packing up to 400 gallons per day the filling may be done by hand with a dipper having a spout, a funnel with a valve, or from a tank fitted with a short hose and pressure valve. The filling can be done immediately after finishing, taking advantage of the heat already in the sirup and thus minimizing the work of sterilization, or it may be done from storage tanks as needed. A double seamer to make a hermetic seal is the preferred method for closing cans and the screw cap the simplest type for glass. A short heating in an open bath as a precaution against infection from packaging followed by cooling complete the arrangement. In the larger plants, mechanical handling of containers, filling, closing, sterilizing, and labeling follow the same general plan as for other products. While the spoilage losses in sirup are not large, they may be reduced still further by using the same precautions followed with more easily perishable products.

**Label Weights**

The weights recommended for declaration upon the labels are as follows: 8Z Short, 7 ozs.; 8Z Tall, 7¾ ozs.; Picnic—No. 1 East, 9½ ozs.; No. 300, 13½ ozs.; No. 1 Tall, 15 ozs.; No. 2, 1 pt. 2 ozs.; No. 2½, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; No. 10, 3 qts.

**Difficulties**

The difficulties in the manufacture of sirups—sugar-cane, maple, and sorghum—on a small scale are largely due to not keeping the equipment strictly clean and to fermentation due to the several steps not being followed in sufficiently rapid succession. The sugar-cane juice has a sugar content which favors rapid growth of organisms and, as many of the holding tanks are of wood which become heavily infected and are not sterilized, they add to the infection in the course of manufacture. The scum and fine
flocculent matter precipitated in the boiling, bakes or burns on the evaporator and being difficult to remove, contributes a bad burned flavor to the product. Strict cleanliness by soaking out the pan when the day’s work is done, cleaning and polishing the metal before using, sterilizing the tanks, troughs, buckets, dippers, etc., with steam or boiling water are highly important. These are necessary steps in any line of high-class food manufacture. The sirup making season is so short that costly metal tanks and well-finished permanent buildings are not feasible so that deficiencies and the conveniences of a fine plant must be made up for by greater efforts and labor with what is available.

**Maple Sirup**

Maple sirup is a native American product produced by the Indians long before the white man set foot upon these shores. It is not known when they learned how to produce it, the legend regarding the discovery being pretty strongly colored by the story teller. However, the fact remains that maple sirup was one of the outstanding features of Indian culinary art. A thick heavy maple product and concrete was an article of considerable barter among the tribes in the northeastern states and along the St. Lawrence river.

That the Indians employed crude methods in obtaining this product may be readily imagined from the extremely limited means for obtaining the sap and for reducing it to the proper consistency. The sap was obtained by bending the limbs of the trees and breaking them off, then catching the drip in crude pottery, sea shells, birch bark fashioned like bowls, or other objects which might serve the purpose. Notching the tree with a stone axe was also another way. Evaporating the sap was even more difficult. Fallen logs were burned out and dug out until a cavity was made large enough to hold a considerable quantity of sap or birch bark was made to serve the same purpose. Stones were then heated and dropped into the sweet water. Another way was to use the fresh skin of an animal as a bag to hold the sap and drop stones into it or suspend it in front of but not in contact with a fire. They are also said to have allowed the sap to freeze and removed the ice. One marvels at the lengths to which they went and the ingenuity displayed in getting this sweet sirup by comparison with the crudity of their daily cooking.

The whites appreciated the unusual flavor of the sirup and quickly applied themselves to improve upon the methods of the native. They used an augur for tapping the trees, made spiles from stems of the elderberry bush, felled small trees, split them and chopped out troughs for collecting the sap, thus making it possible to collect several times as much as could possibly be gathered by the Indians. Even the small iron kettles which the immigrants brought with them made evaporation easy, so that with these simple facilities they succeeded in making enough sugar for their needs and thus became independent of imports of cane sugar. Maple sirup and sugar became important articles of manufacture in the home in the northeastern section of the country, and remained so until about 1875. According to the first agricultural census, taken in 1839, the production of sugar amounted to 31,000,000 pounds in the northern states, which
necessarily was maple sugar. At that time practically all the sap was reduced to sugar as the safest and most economical way to keep it. As the population was only about one-fourth that at present and the per capita consumption of sugar was only about one-tenth, one readily grasps that this was an important item. It did not become an article of commerce until about 1770. The small volume produced at present is indicated in the general table already given.

Maple sirup is a limited product, limited by nature to that made from the sap of a few trees, *Acer saccharum* and its three or four varieties. While these are distributed widely over a large part of the country, they occur in greatest abundance only in the northeast and in southern Canada. Vermont leads with 5,300,000 trees in production, New York second, and Ohio third at present. The tree is of such slow growth that planting for sirup production is not profitable, therefore dependence is placed upon the natural forests, and these are disappearing. A further limitation is that of climate. Sap flows for only a short time in the spring and in some seasons can be obtained on only one or two days, and in other years at intervals over a couple of weeks or more. At its best it is irregular. In many places it is never worth the while to open camp. By modern methods of tapping, metal spouts, buckets with covers, and shallow evaporators, a higher yield is obtained from the same number of trees than formerly, but the total serves only to supply flavor for sugar sirups, fine candies, and confections. The low saccharine content of the sap, from 2 to 4 per cent sugar, and high labor cost of manufacture obviously prevent its use in competition on a sugar basis with other sirups. Its value lies in its distinctive flavor.

Maple sirup is made in nearly the same manner as cane sirup, but only in early spring, often when there is snow on the ground, and more or less freezing and thawing. The sap is caught in buckets at the trees and collected in barrels or a tank dragged about on a sled. It is strained through heavy flannel into barrels and preferably allowed to settle before being drawn off to boil.

It is important that the sap be protected as much as possible from dirt of every kind as this produces color and cloudiness in the finished product. Also that the sap be collected at frequent intervals to prevent the growth of mold or souring. The mere fact that it is cool at the time sap is running does not preclude the growth of micro-organisms. It is sometimes even necessary to scald the spiles or make fresh holes in the trees to prevent spoilage in the sap.

For very small production, as on farms, kettles are adequate to do the boiling but when the camp or bush contains more than 400 trees, an evaporator of appropriate size is preferred. These are the same as described for making sugar-cane sirup. Evaporation is figured on the basis of about two gallons per square foot of furnace exposure per hour. A small pan, 3 by 8 feet, has a capacity of from 45 to 50 gallons of sap per hour, and since the sap has such a low sugar content that it has to be concentrated at the ratio of 20 to 30 to 1, the importance of this economical device becomes apparent.

If kettles be used, it is important that each batch be reduced to sirup as a unit. When the contents of a large kettle is reduced to a sufficiently small quantity, it may be transferred to a smaller kettle and finished but it is
detrimental to quality to add sap to partly concentrated sirup in order to increase the batch.

The sap is run in at one end of the evaporator in a thin layer of about one inch and skimmed promptly on the appearance of scum. No clarification or other treatment is needed if the sap has been kept clean, since the sirup is free from flocculence. If it be desirable to clarify, this may be accomplished by adding the beaten whites of two eggs for each gallon of sirup when nearly finished. One-fourth of a pint of milk may be substituted for the eggs. These will be coagulated by the heat and trap the sirup solids so they may be skimmed from the top. The color is normally dark.

The sirup is finished when it reaches a density of 11 pounds per gallon, equivalent to a boiling point of 217° to 218° F. in the principal producing region but may be slightly less at some of the higher elevations. The Brix spindle may also be used, when the finished product should read between 66° and 68° at ordinary temperature or with the corresponding figure at the temperature of testing. A sirup below 11 pounds per gallon is thin and likely to ferment and it is practically certain to do so if it tests below 10.0 pounds per gallon. If the weight exceeds 11.5 pounds per gallon, sugar separates, first as very small crystals which grow in size until the sirup becomes weakened so that in time it spoils on exposure. The best preservative effect is obtained by finishing within a narrow range at 11 pounds per gallon, containing a total of 65 per cent sugar solids.

When the sirup is finished in the evaporator, it contains some suspended matter as protein and salts which have been precipitated by the boiling. In order to have a brilliant sirup the product may be allowed to settle for two or three days and the clear portion drawn off, or an alternative is to filter through thick flannel while hot. Those who appreciate maple sirup most for its real flavor will prefer that the solids remain rather than have super-clarity.

Sirup made directly from the sap is known as "maple sap sirup" in the trade and that from dissolving concrete as "maple sugar sirup," the former being given preference on the basis of flavor.

Maple sirup is packed in either tin or glass containers, with some preference for the latter as a matter of merchandising.

Maple Sugar

Maple sugar or concrete is produced by boiling the sirup to 242° F., pouring it into forms in thin layers and cooling quickly. If cooled quickly, fine crystals are produced while if cooled slowly, the crystals will be of large size. This is the product most used in making maple sirup during the year and for mixing with other sirup to give flavor. It saves in the cost of packaging and in freight. The concrete is broken up, water added and boiled until the proper density is obtained.

Two other maple products are of interest though outside the canning field. They are soft maple sugar and maple cream.

Soft maple sugar is obtained by boiling the sirup to 232° F., keeping the sides of the vessel wiped to prevent the formation of crystals and then pouring the heavy sirup in pans to a depth of one-half to three-fourths of
an inch and cooling quickly by setting on ice or snow, or in a tank of cold water. When the temperature has been reduced to about 70° F., the mass is slowly stirred to prevent the formation of crystals. This is continued until the mass begins to set. If the work be done properly there are no small crystals, “sand,” present.

The maple cream is covered by a patent, No. 1,245,669, issued to Alice E. Brown, Shelburne Falls, Mass., Nov. 6, 1917. The essential portion is quoted:

Heretofore it has been found practically impossible to so treat maple syrup in quantity as to produce a smooth, soft, fine grained, creamy result, especially in cake form.

In carrying out my method I take the pure, clean, maple syrup and subject it to boiling action until it reaches a temperature of substantially 236° F. I then pour the same in shallow pans preferably of say four quart capacity, depositing the sirup to a depth of about one and one-half inches. The sirup is then cooled to a temperature of 100° F. This I accomplish most conveniently by placing the pans in a water tank and allowing cool water to flow around the pans until the temperature of the sirup is reduced to the desired point. The contents is then subjected to a stirring operation. This I prefer to accomplish by the employment of a stirrer or mixer operated by power and I prefer that the stirring be quite rapid, that is to say the stirrer should revolve at about 700 revolutions per minute and that the stirring operation be continued until the mass begins to harden and reaches a point where it is likely to begin to granulate at which point the stirring operation is discontinued and the pan with its contents is inserted in a double boiler and heat applied until the material has reached a creamy consistency, this being when the same has reached a temperature of about 138° Fahrenheit. The material is then run into molds of any suitable or desired form and allowed to cool after which it will be found to have hardened and still retain its creamy character. In other words the material will have attained a condition which is known as “smooth.”

Sorghum Sirup

Sorghum belongs to the coarse grasses in the family *Andropogoneae* and is closely related to sugar cane. Its cultivation dates back to very early times in western Asia and northern Africa and probably to an even earlier period in China and India. The chief usage at that time seems to have been for its seeds as they are similar to millet and were used extensively in the making of flour. Sorghum has been used for many centuries in southern Europe but its introduction into this country is uncertain. The credit is usually given to William R. Prince, a nurseryman of Flushing, New York, who in 1853 brought seed from France. A couple of years later the government obtained seed from various sources and distributed them widely to determine the suitability of the plant for cultivation under local conditions. Other importations of seeds, especially from China and India, followed and from tests made it was learned that good crops might be expected over a considerable section of the country. The census of 1859 records that sorghum sirup was made in thirty-two states, as little as 20 gallons in Rhode Island and as much as 1,211,000 gallons in Iowa, with a total of 6,750,000 gallons for the entire country. This makes the date as just given seem improbable for it is not conceivable that a new plant could have been so widely distributed or that the people should have learned the art of making the sirup in the short period of six years. The Civil War interrupted the government work which was not resumed until about 1880, but the plant had found a definite place as an adjunct to the garden in furnishing sirup for the family and the community. The resumption of interest
APPERTIZING

in sorghum was with the idea that it might be made a source of sugar but the objective was defeated for want of a method of separating and refining the saccharine material. The growth and importance of sorghum as a sirup producing plant is shown by the following statistics.

CENSUS ON SORGHUM SIRUP PRODUCTION

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1859</td>
<td>6,750,000</td>
</tr>
<tr>
<td>1869</td>
<td>16,050,000</td>
</tr>
<tr>
<td>1879</td>
<td>28,444,000</td>
</tr>
<tr>
<td>1889</td>
<td>24,255,000</td>
</tr>
<tr>
<td>1899</td>
<td>16,972,000</td>
</tr>
<tr>
<td>1909</td>
<td>16,552,000</td>
</tr>
<tr>
<td>1919</td>
<td>21,523,000</td>
</tr>
</tbody>
</table>

At the present time, Kentucky leads in production.

Sorghum is grown under practically the same conditions as corn but owing to the time required for maturing is not grown so far north. There are about five fairly distinct types and a very much larger number of varieties offered by seedsmen from which a suitable type may be selected.

The Amber is the earliest maturing type and therefore the one chiefly used in the most northerly belt. It is a rather small plant with light stems and few leaves. By heavy seeding it gives a fair yield per acre. The time required for maturing is from 70 to 100 days.

The Orange has a heavier stalk with broader leaves but is not a tall grower. It does best on a moist soil and requires about 15 days longer to mature in the latitude of Kentucky.

The Sumac or Red Top is another type of moderate size, growing from 7 to 10 feet in height but with sturdy stalks. It is slow in maturing, needing from 90 to 120 days. It is grown extensively in Tennessee and in that latitude and farther south. The seed head is reddish brown, like the sumac and from this resemblance derives its name.

The Gooseneck is the most distinct type in that the head turns over on the stem. It is a tall grower, from 10 to 12 feet and more in rich soil. The stem is large so that the yield is above the types already named. It requires from 110 to 140 days to mature which limits its range to the south.

The Honey is a thick stemmed succulent variety of limited height. It requires a long season to mature so that it is especially suitable for Texas. Sorghum yields from 2 to 6 tons of stalks per acre in the north and from 8 to 12 tons in the south with variations in between. It is grown chiefly in small patches of from 1 to 5 acres so that naturally there is wide variation depending upon the plot selected and care bestowed in cultivation.

The plant is considered to be mature when the seeds are beginning to harden. If cut much before that time the flavor is poor, sometimes described as "green," and if cut late the flavor is not at its best and the juice difficult to clarify. Green sorghum is seriously injured by frost but the mature resists severe frosts and may still be used for sirup. The yield of juice varies from 750 to 1200 pounds per ton, depending on the state of the crop and the pressure used in grinding. The resulting sirup varies from 8 to 20 gallons per ton.

Harvesting begins by topping, that is, cutting off the top and about one foot of the stem by means of a corn knife, followed by stripping the leaves. The stripping is done by means of a short broad paddle with a notch cut into the end so that when quickly run along the stalk the leaves will be broken back or stripped. Topping is necessary, as crushing the seeds adds an undesirable flavor, and permitting the leaves to remain, reduces the
capacity of the grinder and introduces a higher proportion of gummy and other substances which interfere with making the best quality of sirup. The two operations entail a considerable amount of field work which might be eliminated by some stripping device on the feeder at the mill. The cutting of small patches is done with the usual corn knife though for large patches it is more convenient to use the corn binder. The cutting may be done immediately after stripping or delayed for a few days. Some sirup makers prefer that the stalks remain standing for a day or two. After cutting, the stalks should be handled promptly through the mill to prevent souring or other changes and to yield the maximum amount.

The production of sorghum sirup is carried out with the same kind and size of equipment as that used for making sugar-cane sirup. The 10 ton per day unit is most nearly standardized for home and community operations.

The first step after grinding is to allow the juice to settle for two hours or more as a greater quantity of extraneous matter can be separated by that method than by any other.

The second step in clarification is to heat the juice to near the boiling point in a settling tank, skim well, then allow the juice to settle and draw off the clear portion. Heating is best done with a coil or by direct steam if a boiler is available but in its absence, it may be done in the evaporator and then returned to the tank to settle. A small quantity of lime may be added as in sugar-cane sirup, care being taken that it does not approach too closely to the neutral point. Clay formerly used is now considered added dirt, a part of which cannot be removed. The desired effect can be obtained by allowing a little more time in the settling. The clarified juice or semi-sirup may be treated with invertase to prevent sugar crystallization, following the same procedure described for cane sirup. Evaporation is carried out in direct fired evaporators or with steam coils as previously described for cane sirup.

Sorghum juice enters the evaporator testing from 7° to 14° Brix but must test 70° when finished at 60° F. This is higher than for sugar-cane sirup and corresponds to a boiling point of practically 224° F. The ratio of concentration varies from as wide as 10 to 1 and as narrow as 5 to 1. A gallon of sirup is required to weigh 11.25 pounds.

The canning equipment and containers are the same as described for sugar-cane sirup.

**Corn Sirup**

Corn sirup, formerly called glucose, is a product resulting from the treatment of corn starch with a weak acid, causing it to change in character so that when concentrated, it becomes a sweet sirupy material of high food value. It is not a pure sugar but a mixture of glucose, maltose, dextrine, and probably other closely related substances. The percentage of the different constituents is not constant, though the variation is much less now than formerly due to improved manufacturing technique. It is unfortunate that this product is often confused with \(d\)-glucose or dextrose which is a distinct type of sugar with a definite chemical formula.
The history of this sirup had as a forerunner, the recognition of a peculiar variety of sugar, dextrose, obtained from grapes by Löwitz in 1792, and given the common name “grape sugar.”

In 1811, Kirchhoff, at St. Petersburg, while trying to make gum from starch (sometimes stated to be trying to make cane sugar from starch), found the same type of sugar resulting when starch was treated with dilute acid, a most important discovery, since it is the one upon which the manufacture of all starch sirups depends. His experiments seemed so simple and conclusive that crude commercial methods were evolved and put into operation at once. The stimulus for the haste was the nearly complete blockade of all European ports due to the Napoleonic wars then in progress. Sugar was so effectually shut out of the country that it had become a luxury. After the war was over the emergency passed and cane sugar became available with the result that the manufacture of starch sugar ceased.

In 1819, Braconnet found that this sugar might be obtained also from the fibrous tissues of plants, having obtained it from sawdust and linen rags. As the chemistry of sugars became better known, this one was found to be a fundamental type occurring in nature, usually associated with sucrose in honey, most fruits, the juices of plants, and traces in the blood stream of the higher animals as well as in some of the tissues. It also results from the inversion of cane sugar when acted upon by dilute acids and by the action of certain micro-organisms. This sugar, dextrose, is not as sweet as sucrose, the ratios being given as close as 3 to 2 and as wide as 5 to 2. Pure dextrose is immediately assimilable in the body and therefore supplies energy more quickly than any other known product used as food.

The commercial manufacture of starch sirup was taken up seriously about 1850, following essentially the method developed by Kirchhoff but with improvement in detail, the principal one being the acidulating of the starch at higher temperature than boiling or under pressure. The Germans were most active in the field and used the potato exclusively as the source of raw starch. The industry had its beginning in this country about 1860 but as corn became the basic raw material, from it was developed the trade name “corn sirup,” though first marketed as glucose. The manufacture of solid or dry sugar made comparatively little progress until improved methods of converting the starch and crystallizing the sugar were developed during the war.

In a “Report on Glucose, prepared by National Academy of Sciences,” 1884, the method of preparation is summarized as follows:

“The process of making starch-sugar consists, first, in separating the starch from the corn by soaking, grinding, straining and settling; and second, in converting the starch into sugar by the action of dilute sulphuric acid, the acid being subsequently removed by the action of chalk. To make the solid, ‘grape sugar,’ the conversion is carried further than to make the liquid, ‘glucose.’ After clarifying, the liquid is concentrated in vacuum pans and is decolorized with boneblack.”

While the basic principles in the manufacture of corn sirup remain the same as when the report was made, great progress has been made in the technique, insuring a higher degree of purity in the starch and complete control of conversion so that the quality of the sirup can be regulated within a narrow range.
The use of corn sirup increased enormously between 1900 and 1920, the greatest stimulus, however, was the World War. It exceeds all other table sirups combined and also has a very large use in baking, confectionery, brewing, and vinegar-making. The fact that corn sirup is not as sweet as sugar sirup and has a more viscous body is to its advantage since thereby it serves as an excellent vehicle for blending, wherein it becomes the base and other sirups and molasses serve as the flavoring materials—sugar sirup, sugar-cane sirup, sorghum, maple sirup, refiners' sirup, and molasses—in various combinations, the total of the flavoring material being between 5 and 10 per cent. These blends are made and packed by numerous firms that purchase their stock materials from many sources.

The production of corn sirup is in few hands since it requires close technical control of every detail and depends upon volume of sales for profits. Figures are not available concerning the requirements of the largest corn sirup plant but since starch manufacture must precede that of sirup or sugar, some conception of the huge scale of the operations may be gained from the fact that the largest starch factory uses between 45,000 and 50,000 bushels of corn in 24 hours, approximately 90 carloads of raw material.

The corn used may be either yellow or white, though the former is preferred as it may be worked through the starch operations a little more smoothly than the white. The corn of either color must be of good quality, not lower than No. 2 grade. The sound shelled corn is cleaned of husk, silk, bits of cob, and damaged grains by screening and suction, then washed in rotary washers under strong sprays of water and conveyed to the steeping vats. Here the grain is softened and the starch cells swell by taking up water. The vats hold from 1,000 to 3,000 bushels each and water is added to cover, making due allowance for that which is absorbed. Sufficient sulfur dioxide (about three-tenths of one per cent) is added to the water to prevent the growth of micro-organisms. A constant temperature of 125° F. is maintained by circulating the water to produce a rapid and uniform effect upon the grain. Steeping requires from 36 to 48 hours, depending upon the age of the corn.

When this step is completed, the water is drawn off, the corn washed and immediately sent to the breaking mill where the grains are cracked or broken but not finely ground. The cracking is done between rotating steel disks spaced so as to get the desired effect. The broken grains are discharged into V-shaped tanks filled with water where the separation of the germ and oil takes place. As both of these are light and float on the surface, they are skimmed or floated off while the starch, hull, and fibrous portions drop to the bottom. The completeness of the separation depends upon steeping and therefore the importance of this preliminary step.

The cracked grain, minus the germ and oil, is next ground in a mill similar to the old type of burr flour mill but the grain being wet results in a thin creamy product like table mustard. The object is to tear the starch cells and other tissues apart rather than to break them into pieces.

Next in order is the separation of the fiber from the starch which is accomplished in two stages, first by washing in a finely perforated reel in which the starch passes through the perforations and the coarser fiber goes over the end as tailings; and second the discharge of the starch upon silk bolting cloth which is stretched over a screen kept in rapid vibration.
To free the gluten from the starch, the liquid mass is floated in long shallow troughs about 9 inches deep, 2 feet wide, and from 100 to 150 feet long. The mass is run in very slowly so that the starch settles to the bottom and the gluten floats on the top and off at the farther end. This operation has to be regulated to a nicety or a part of the gluten will settle with the starch and injure the product.

All the water is drawn off above the crude starch cake which is then ready for a final washing and pressing. That used for making corn sirup is thoroughly beaten up with water to test 44° Brix, run into large open tanks, and then brought to boiling. The necessary quantity of hydrochloric acid, about .25 per cent, is added to effect hydrolysis. Originally sulphuric acid was used but hydrochloric acid is equally effective and has the added advantage of being converted into common salt when neutralized, thus leaving no objectionable residue.

The batch is next dropped into converters which are heated under a steam pressure of 35 pounds to the square inch (280° F.) and held for the time necessary to convert about one-half the starch into dextrose, the remainder being in the form of maltose, dextrin, and other intermediate products. The time in the converter is controlled by frequent testing.

As soon as the converter is opened, the batch is neutralized with sodium carbonate, care being taken not to make it alkaline. Since the amount of added acid is known, this is a very simple matter.

The batch is cooled and discharged into the bone-char filters where it is left from 36 to 48 hours, the contents being circulated over the char three or four times. The filtered liquor tests about 55° Brix and should be water white. Final concentration is done in a vacuum pan to between 76° and 82° Brix when read at 100° F. The sirup is then cooled and filled into tank cars, barrels, or steel drums for large users or distributors, and the remainder canned straight or blended.

Plain tin cans are used in sizes already indicated for other sirups and the same weights are used on the label as indicated for sugar-cane sirup.

The canning of corn sirup is attended by fewer troubles than with other sirups and with as little as any other commodity.

To sum up the matter, a bushel of corn will yield about 35 pounds of starch, 17 pounds of gluten feed, and 1.5 pounds of oil. The starch upon conversion will yield 36 pounds of corn sirup though theoretically this is not the maximum.

**Definitions Under the Federal Food and Drugs Regulations**

Sirup is the sound product made by purifying and evaporating the juice of a sugar producing plant without removing any of the sugar.

Sugar-cane sirup is sirup made by the evaporation of the juice of the sugar-cane or by the solution of sugar-cane concrete, and contains not more than 30 per cent of water and not more than 2.5 per cent of ash.

Sorghum sirup is sirup made by the evaporation of sorghum juice or the solution of sorghum concrete, and contains not more than 30 per cent of water and not more than 2.5 per cent of ash.
Maple sirup is the sirup made by the evaporation of maple sap or by the solution of maple concrete, and contains not more than 35 per cent of water, and weighs not less than 11 pounds to the gallon (231 cubic inches).

Sugar sirup is the product made by dissolving sugar to the consistence of a sirup, and contains not more than 35 per cent of water.

Molasses is the product left after separating the sugar from massacuite, melada, mush sugar, or concrete, and contains not more than 25 per cent of water and not more than 5 per cent of ash.

Refiners' sirup, treacle, is the residual liquid product obtained in the process of refining raw sugars, and contains not more than 25 per cent of water and not more than 8 per cent of ash.

Glucose, mixing glucose, or confectioner's glucose, is a thick, sirupy, colorless product made by incompletely hydrolyzing starch, or a starch containing substance, and decolorizing and evaporating the product. It contains on a basis of 41° Baume not more than 1 per cent ash, consisting chiefly of chlorides and sulphates.

Sugar Beet Sirup

Sugar beet sirup has been used in the homes of beet growers for a number of years but has never become a commercial product. A patent was taken out for such a product, No. 1,155,806, October 5, 1915, in favor of H. C. Gore, Takoma Park, Maryland, and C. O. Townsend, Washington, D. C. The essential part is as follows:

Our invention relates to a process for preparing syrup from sugar beets.

In practising our invention, we first remove the crowns from the beets and wash the product, and then cut the beets into thin chips or slices, preferably by means of a suitable vegetable cutter. Upon reducing the product to small sections or parts, we place the treated material in a suitable vessel or receptacle, adapted to be heated by any convenient means, and cover the chopped material with hot or cold water. We then heat the vessel containing the treated beet material and water by direct fire or by heat supplied from any convenient source until the temperature of the mixture is raised to or near the boiling point. We then subject the mixture to such temperature for a period sufficient to extract sugar from the beet material. The time consumed for this purpose depends largely upon the thickness of the slices or chips. We find that it usually takes from one-half hour to two or more hours to remove sugar from the sliced beet material by boiling. In practice, we have discovered that the thinner the slices are cut, the shorter the time required to remove the sugar from the beet sections. From experiments we have ascertained that in cases where thin chipped beets are used, it only required about one-half hour of boiling to extract the necessary amount of sugar from the beet product, and that in cases where beet slices are used, which are approximately one-quarter inch in thickness, it requires about one and one-half hours to remove sufficient sugar from the beet for the purpose of producing the product herein described. During the period of boiling the mixture, we find that a large proportion of the sugar and other diffusible substances in the sliced or chipped beets pass into the water, and by treating the water absorbing the sugar and other diffusible substances from the beet product in the manner as we hereinafter describe, a savory and delicious syrup can be produced. When the mixture specified has been sufficiently boiled to effect the removal from the beet material a large proportion of the sugar and other diffusible substances present in the product, we then remove the boiled beet product from the liquid by using a dipper having a perforated bottom, so that the liquid scooped up with the beet material may drain back into the kettle or vessel. It is desirable that all the beet material should be removed from the liquid. At this stage the liquid has an objectionable flavor; consequently, to remove this objectionable flavor, and to reduce the liquid to syrup, we subject the liquid to further heat treatment. The liquid extract is slowly boiled down until it reaches the condition of syrup. During this
process it is desirable occasionally to skim the liquid or to remove therefrom particles of suspended matter which are conducive to cause burning by sticking to the sides of the kettle or vessel under the surface of the boiling liquid. The liquid extract should be boiled from two to four hours, and we find that it is advisable to boil the extract very slowly during the first period of evaporation, and then boil the extract rather rapidly toward the last, in order to avoid scorching the syrup. If the syrup is scorch, it will possess a bitter flavor. We find that, if the liquid extract is treated in the manner as herein described, the resulting product will consist of a syrup of delightful and pleasant flavor. The beet material removed from the heating vessel may again be treated in the same way with fresh quantities of water for extracting therefrom further amounts of sugar, but we prefer to discard the cooked beets, inasmuch as they can be used as a stock feed for cattle or hogs, or devoted to any other purpose for which they may be adapted.

Raisin Sirup

Patent No. 1,746,993, was issued February 11, 1930, to J. K. Dale, Fresno, California, and is as follows:

This invention relates to the production of improved sirups or extracts from raisins and other similar fruits, which can be utilized as sweetening agents and as raw material for fermentation in the factory or household.

The sirups or extracts from raisins and similar fruits have not been widely produced or used because they contain a large number of objectionable impurities, many of which are of unknown composition. These impurities give rise to an unpleasant flavor, to a dark coloration, which tends to increase as the sirup ages, and to other undesirable properties of the sirup or extract. Some of the known impurities in the raisin extract or sirup are acid tartrates, which appear to be in a large degree responsible for the strongly acid condition of the extract or sirup, tannin bodies and protein material. Some of the coloring matters present in the sirup or extract can be easily removed by decolorizing carbons, as bone char or activated vegetable chars, but a large part cannot be readily removed by these agents. The sirups from raisins and other acid fruits usually are composed mainly of invert sugar, which tends to crystallize upon concentration of the sirup or extract.

Because of these many factors a fundamentally different problem is faced in the refining of raisin sirup than is faced in the case of the refining of sirup from cane, beet, and many other vegetables or fruits. In the refining of cane or beet juices or sirups, the ultimate object is to produce dry crystalline sugars, and a sirup or molasses is formed as a by-product. Contrary to this, the ultimate object of the present invention is the production of a sirup, or a magma of crystals in sirup, from raisins. In the making of sugar from cane or beet sirups, the non-sugar impurities can be washed away from the crystals after the formation of the crystals in the final steps of the process, but in the refining of raisin sirups or like sirups, it is impossible to remove the impurities in this manner in view of the fact that the sirup, and not the crystals, is the final product.

The sirups from the cane and the beet are composed principally of sucrose, while sirups prepared from raisins or other acid dried fruits consist principally of invert sugar, a mixture of dextrose and levulose.

When a fruit extract, the solids of which consist essentially of invert sugar, is evaporated to a heavy consistency such as about 80° Brix the dextrose constituent of the invert sugar has a tendency to crystallize, producing a magma which for many purposes is undesirable.

The character of the impurities found in raisin sirup differs greatly from the character of those found in cane or beet sirups, and the methods which must be employed to remove such objectionable impurities are very different.

The object of this invention is to produce a refined raisin or like sirup which will be free in a large degree from the impurities which cause an objectionable flavor and darkening in color. Another object of this invention is to produce a concentrated raisin sirup which will not readily crystallize.

It has been found that if a raisin extract which is strongly acid is obtained from the raisin, is subjected to an alkaline treatment, a large number of the objectionable
impurities will be precipitated or neutralized. Also it has been found possible to reduce the acidity and to remove a substantial portion of the non-sugar solids by concentration. In the case of the employment of an alkaline treatment, the sirup or extract should be left in alkaline condition as short a time as possible, in view of the fact that a condition of alkalinity appears to produce discoloration. It is possible to retard or to prevent crystallization of dextrose in the concentrated sirup by the addition of sucrose, or by the addition of some material which contains sucrose, during some step in the process.

The preferred method of purifying the sirup or extract is to add a caustic alkali, for example caustic soda, to the acid extract or sirup until it becomes slightly alkaline. Other alkalies may be used instead of caustic soda, but caustic soda is preferred. Before this alkalinizing step, the extract may be concentrated, which will cause the precipitation of a large amount of the acidic material present, and which will therefore reduce the amount of the alkali which must be used in the alkalinizing step. At some stage of the process, or at several stages, the sirup should be subjected to a treatment with vegetable or bone char, in order to remove a substantial portion of the coloring matter.

The following is a detailed method of procedure, but this invention is not restricted thereto, and many variations can be made in the process and many steps can be omitted.

Raisins, or similar dried fruits, such as figs, dates, prunes, apricots, peaches, berries, bananas, apples, etc., are stemmed, cleaned and perforated, and then extracted with water in a battery. There may be mixed with the raisins at this point some other fruit, which will produce a substantial amount of sucrose in the resulting sirup. The removal of the desirable sugars from the raisins may also be accomplished by special treatments. The raisins may be treated first to break and remove the skins and seeds. Then they may be pressed, squeezed or centrifuged with water, steam and the like.

This extract is filtered to remove the suspended impurities, and the extract at this point may be treated with some adsorbent decolorizing agent to remove a portion of the coloring matters, but this step may be omitted at this point. The filtered extract is then evaporated to a density of approximately 55° Brix. This semi-sirup which has been produced by the evaporation step is cooled, whereupon a large amount of the non-sugar solid content will crystallize. The semi-sirup portion will consist principally of cream of tartar. At this stage, the sirup is still strongly acid having a pH value of about 5 to 5.5.

The semi-sirup is then filtered to remove the precipitate. For the next step the filtrate should be diluted with water to density of not more than 50° Brix, or it may be reduced to 35° or 40°, but more dilution than is necessary is to be avoided since the sirup in the final stage of the refining process must be reconcentrated to about 80° Brix.

This diluted semi-sirup is then neutralized with caustic soda until it is slightly alkaline. After this alkalinizing treatment, it should have a pH of preferably about 7.5. Instead of caustic soda, any other alkali, such as potassium hydroxide, sodium carbonate, sodium aluminate, sodium silicate, or sodium phosphate, could be used. These last three are not very satisfactory, inasmuch as they are expensive, and moreover cause the formation of other precipitates and add foreign matter to the liquor which would have to be subsequently removed.

The neutralized or alkalinized liquor is now heated to about 65-75° C. At this point there will be a coagulation and separation of impurities mostly of unknown composition, which will result in the formation of a flocculent precipitate. It does not appear that all the objectionable impurities contained in the sirup are removed in this precipitate, but it does appear that a large portion of the unprecipitated impurities have been so changed by the treatment with caustic alkali that they no longer are present in objectionable form. The semi-sirup is then filtered to remove these coagulated impurities. Filter aids, such as kieselguhr may be added to expedite the filtration.

The clear filtered liquid is then acidified, preferably to a pH value of about 5.5. Hydrochloric acid is a most satisfactory acid to use, although phosphoric acid, sulfuric acid or edible organic acids may be used in place of hydrochloric acid. This acidification step should take place as soon as possible after filtration to prevent, so far as possible, the darkening which tends to take place while the liquor is in alkaline condition. The acidified liquor is then evaporated to about 55° Brix. In case the liquid has not been diluted during the process, this evaporation or concentration step would not be necessary, but it is probable that the liquor at this stage will have been diluted by the admixture of wash water from the filter press cakes.
Although the liquid could be decolorized at other points by treatment with a decolorizing agent having a high adsorptive power such as bone or vegetable char, this is the preferred point for subjecting the process liquor to a decolorizing treatment. After decolorization the liquid is evaporated to a finished sirup of about 80° Brix.

The use of caustic soda or another alkali metal compound as alkalinizing agent is much to be preferred over the use of lime or other alkaline earths. In a treatment with lime it is necessary to first dilute the semi-sirup from which the tartaric acid compounds have been removed by concentration to about 30° to 35° Brix. This makes necessary a very expensive concentration or evaporation during the latter stages of the process. Also the removal of the last traces of lime is very troublesome and unless the lime is completely removed, a cloudiness or precipitate will be formed in the finished sirup, due to a combination of the calcium with various ingredients of the sirup. To remove the lime it would be necessary to carbonate the limed liquor, filter out the precipitated calcium carbonate, and then in addition to add expensive phosphoric acid or phosphates to remove the residual calcium remaining in solution after the carbonation. In the caustic alkali process it is unnecessary to carry out these expensive and tedious purification operations.

The sirup prepared by this process has the advantage of being neutral in flavor, the flavor characteristics of raisins being removed for the greater part and it therefore can be utilized in many instances where a raisin flavored sirup would prove undesirable.

A heavy sirup produced from raisins or other fruits, whose sugar is primarily invert sugar, by the above process or any other process, is likely to partially crystallize to a semi-solid magma. This crystallization can be retarded or prevented by admixing with the fruit extract sucrose or sucrose containing material. The sucrose or sucrose containing material can be mixed with the extract or the concentrated sirup or at any convenient intermediate stage.

When sucrose is used it is preferred to dissolve the sucrose in water to make a semi-sirup of about 50° Brix and mix this semi-sirup into the process semi-sirup just before treatment with the decolorizing carbon. It is preferred to add an amount of sucrose that will equal about 25 per cent of the total solid content of the semi-sirup which has been obtained from the raisin or other acid fruit. But, of course, the addition of sucrose at this stage would be unnecessary if during the extraction step there had been present an amount of sucrose containing fruit, which would result in the addition of sufficient sucrose to the process liquor to give the desired effect. Other sugars could be used in place of sucrose to retard the crystallization.

Honey

Honey is the basic sweet among all foods, having been used from time immemorial, before the first vestiges of civilization, and until near the Christian Era occupied the field alone. It was not until twelve centuries later that sugar was produced in sufficient quantities to be a serious competitor. How important it was and how much esteemed is clearly indicated by the number of Biblical references and other ancient writings. The Egyptians apparently knew as much about beekeeping as they did about agriculture and husbandry.

Among historians are many who believe that honey was the first food to be used for condimental purposes or to give flavor to other foods. One of the most interesting objects found in the ruins of Pompeii was a preserve made with honey and stored in glass and earthenware containers.

The honey bee is not native to this country but was brought from Europe by the early immigrants. It escaped from domestication and the wild bees became known to the Indians as “white man’s flies.” The principal honey producing sections are New York and the West, but with a better understanding of the value of bees in fertilizing orchard fruits and other crops, bees are being utilized in other sections for this purpose and thus incidentally extending the honey crop.
Honey is not a natural sweet but "is nectar and saccharine exudations of plants, gathered, modified and stored in the comb of the honey bees." Chemically it is mainly sugar but has in addition the various substances from the flowers which give it distinctive flavor, this depending upon the source of supply, the color ranging from water white to dark amber. The honeys from the citrus, sage bush, white clover, buckwheat, and other plants predominating at certain places or at their flowering time are sufficiently distinctive as to command different prices in the market and are sought also for blending. Another distinction, little known to the public, is that honey is probably the costliest of all foods. Naturalists have worked out the number of trips required for a bee to gather a pound of honey and the wax to make the comb, the number of miles which would have to be flown, the amount of work necessarily expended to evaporate the moisture, the total representing an unbelievable amount of energy. A hive of 50,000 bees, under favorable conditions may store one pound of honey in a day, which means that they must visit more than two million flowers, carry to the hive more than three pounds of raw materials and evaporate more than two-thirds of it by producing currents of air with their wings. The total flight in gathering the honey would approximate a trip around the world.

Honey was formerly distributed in standard sections or frames as taken from the hive but the more approved method is to extract the honey from the comb and pack it in sanitary sealed containers. Only the whitest honey is distributed in the comb for table use, dark honeys are all extracted and used chiefly in baking and confectionery.

Preparation for Canning

As a preparatory step, honey is stored for two weeks or more after it is taken from the hive. This is for ripening, as it is called, or to permit certain changes to take place in the cell, among them the dying off of most bacteria due to the unfavorable food conditions. It is then brought into a warm room at 80° to 85° F. for a day or two to insure that the honey be liquid and flow freely as that will not only facilitate the work but will lessen many small air bubbles becoming entrained during the extraction, filling of jars, etc.

The comb is cut from the sections and all spots removed, then the knife blade is passed under the caps parallel with the surface. This opens all the cells so that the honey can escape freely. The comb is next placed in an extractor which operates upon the principle of separating the honey from the wax by means of centrifugal force. The honey is strained through a fine hair sieve or a loosely woven cloth to remove the solids, as minute bits of comb. As the honey is not strictly clear after this treatment, it is given time for settling, ten days or more, usually more and particularly if the room be below 75° F. so that the honey is thick.

The clear portion of the honey is drawn off and pasteurized preparatory to filling into cans or glass containers. In the West the heating is generally from 145° to 150° F. and in the East from 150° to 160° for 25 minutes. Heat conduction is slow in this product and therefore it is advisable to apply the heat gradually and keep the batch gently agitated during the entire period to prevent the portion next to the heating surface from becoming overheated while that farther removed is below the pasteurizing
point. Higher heating is not necessary, the effect of 165° F., even for a short time injures the flavor. The nectar from flowers is very sensitive to heat and since the flavor is the chief asset, the pasteurization must be conducted with regard to that quality. The cans or jars are sterilized and the honey filled directly from the pasteurizer or the honey may be cooled in the pasteurizer by a reverse operation of running cold water through the heating coil or jacket, the gentle stirring of the batch being kept up. The cooling should be carried to the air temperature. Pasteurization is easy for the reason that the sugars are in such concentrated form that they cannot be readily used by the organisms.

A modification of the pasteurization has been worked out by Dr. E. J. Dyce of the Ontario Agricultural college. The object in this instance is to produce extremely minute sugar crystals in the honey. The honey keeps better and the flavor is much more nearly like fresh honey from the hive. The tendency in the regular pasteurized honey is to form coarse crystals, sand-like, or even large crystals which are readily seen on inspection. The flavor under these conditions is more like a plain heavy sirup.

The preliminary steps are the same as already described. The heating is done slowly with continuous agitation to 160° F., the mass held for only a brief period, and then cooled in the same apparatus to 75° F. At this point two or three per cent of honey containing an abundance of fine crystals is added to the batch and stirred for ten minutes, care being taken that the stirring device does not carry or heat in any air bubbles. The honey is filled into the containers which are taken immediately into a room at 57° F. and held there from two to four days during which time the development of the crystals takes place. The success of the method depends upon keeping the storeroom at the temperature specified as the range for optimum crystal formation is very narrow. The degree selected is not empirical but based upon the physical behavior of the sugars.

An interesting research upon filtering of honey is reported by R. E. Lothrop and H. S. Pain of the United States Department of Agriculture* in which they point out that by rapid heating of honey to 140° to 160° F., incorporating a filter aid of the type of diatomaceous earth, and filtering by means of a plate press, the product can be rendered bright and clear without injury to its delicate distinctive flavor and color.

The method requires that certain steps be observed, the most important of which is that the filter aid be made into a very even paste by first mixing carefully with water until thoroughly wet, filtering off the water, and replacing the same with honey. There must be no break in the continuity between the water and the honey. If the fine filter aid be added to the honey without this precaution, it will carry with it small bubbles of air which are difficult to remove from the sirupy mass. By following the procedure just indicated, the difficulty can be avoided. The paste is then stirred into the honey very slowly, the stirrer being completely submerged so that no air may be whipped into or incorporated in the honey. The amount of filter aid used is about one-half of one per cent of the dry powder.

The honey is drawn from the bottom of the tank by means of a pump which forces it through a heating coil where the temperature is raised to

---

the desired degree and from this directly into the filter-press. There should be no break in the continuity of the flow. The pressure required will vary from about 5 to 60 pounds per square inch as the filter becomes blocked. The usual type of press filters about three gallons per hour for each square foot of surface, depending upon the temperature and pressure used.

About 90 per cent of all market honey is extracted, therefore the importance of careful filtration.

**Composition**

The composition of honey varies due to the raw materials used by the bees, to the state of the weather whether wet or dry, and probably to other causes not so well known. Some of the variations are readily detected by chemical methods while others are in such small quantity or are of such a nature as to be difficult to demonstrate or measure.

The Honey Institute has compiled the following table representing the latest researches.

**Average Chemical Composition of Honey**

**Principal constituents:**

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>17.7</td>
</tr>
<tr>
<td>Dextrose (grape sugar)</td>
<td>34.0</td>
</tr>
<tr>
<td>Levulose (fruit sugar)</td>
<td>40.5</td>
</tr>
<tr>
<td>Sucrose (cane sugar)</td>
<td>1.9</td>
</tr>
<tr>
<td>Dextrine and gums</td>
<td>1.5</td>
</tr>
<tr>
<td>Ash</td>
<td>0.18</td>
</tr>
</tbody>
</table>

**Substances occurring in small quantities:**

- Acids (Formic, Acetic, Malic, Citric, Succinic, Amino)
- Pollen grains
- Beeswax
- Pigments (Carotin, Xanthophyll)
- Albuminoids (Proteins)
- Chlorophyll decomposition products

**Substances difficult to demonstrate quantitatively:**

- Enzymes
  - Invertase (converts sucrose to dextrose and levulose)
  - Diastase (converts starch to maltose)
  - Catalase (decomposes hydrogen peroxide)
  - Inulase (converts inulin to levulose)
  - Aromatic bodies (terpenes, aldehydes, esters)
  - Higher alcohols (manit, nitol, dulcitol, etc.)
  - Maltose, rare sugars (sometimes melezitose, etc.)

Microscopic examination may be used in very many cases to determine the source of the honey from the pollen grains present.

**Difficulties**

Little spoilage occurs in extracted honey if reasonable care be used in pasteurizing and packing. Two conditions arise which cause some complaint in the trade. The first is the occurrence of large sugar crystals in honeys with an unusually low water content and the second is cloudiness from storage at too low temperature.
THE CANNING OF MILK

Evaporated milk constitutes the largest single item among American canned foods, which, taken in connection with the fact that only about five per cent or 1,500,000 cases are exported annually, is significant not only of the importance attached to milk in the diet, but also of the confidence which the public has in the quality. It is accepted on the same basis as good market milk but with the added factor of safety that it is sterilized and protected in that condition. The enormous production of this staple is also a guarantee that it is an economical food, obtainable under many conditions at a cost below that of fresh milk.

Two definitions and standards under the Federal Food and Drugs Act apply directly to this product and a third is so closely related that it is needed to clarify the use of the terms.

“Milk is the whole, fresh lacteal secretion obtained by the complete milking of one or more healthy cows, excluding that obtained within 15 days before and 5 days after calving, or such longer period as may be necessary to render the milk practically colostrum free. The name ‘milk’ unqualified means cow’s milk.”

“Evaporated milk is the product resulting from the evaporation of a considerable portion of the water from milk, or from milk with adjustment if necessary, of the ratio of fat to nonfat solids by the addition or by the abstraction of cream. It contains not less than 7.8 per cent of milk fat, nor less than 25.5 per cent of total milk solids; provided, however, that the sum of the percentages of milk fat and total milk solids be not less than 33.7.”

“Sweetened condensed milk is the product resulting from the evaporation of a considerable portion of the water from milk to which sugar and/or dextrose has been added. It contains not less than 28 per cent of total milk solids, and not less than 8 per cent of milk fat.”

The public generally knows these two kinds as canned or evaporated and condensed milks. The first was plain evaporated milk at the beginning and sold in bulk to reduce the volume in delivery and to obtain better keeping quality for a few days. Its use was naturally limited until a method of canning was developed but now has almost universal distribution for household and large kitchen use. It is practically a double strength milk with nearly all the characteristics of the fresh but sterilized and packaged so that it can be used at any time or place for cooking and other purposes. The latest innovation is to irradiate the milk to increase the vitamin D content. Many users prefer it to fresh milk on an equal cost basis.

Condensed milk is very thick and heavy so that it will scarcely pour from a can or small vessel, due to the added sugar. It is not sterilized but depends upon the preservative action of the sugar for its keeping qualities. Formerly it was packed in small tins and had a general sale at grocery stores as it is safe and a distinct convenience for many purposes. At present, however, the great bulk is packed in No. 10 tins, milk cans, and barrels for use by bakers, confectioners, and other large users as it is too sweet for ordinary culinary purposes. Probably less than 10 per cent finds an outlet in household use.
The perfection of the commercial methods of preparation for both kinds of milk are American. While priority for preserving by canning properly belongs abroad, the work was on an experimental scale and never became a business until Gail Borden made the method of evaporation practical in 1856, nor did anyone engage in the canning of evaporated milk until John Meyenberg found the means for sterilizing it without destroying its character, which did not occur until 1885. The development of the industry was rapid after each invention, and strange as it may seem manufacture of both was stimulated by war, the Civil War in the case of the sweetened or condensed product, and the Spanish American War for the unsweetened or evaporated milk. The growth of the industry has been fairly steady, with less fluctuation than with most fruits and vegetables. The statistics are very incomplete, especially for the early years, but sufficient are available to show the trend which can be seen by taking the production totals at ten year intervals:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total of all manufactured milk</th>
<th>Sweetened milk</th>
<th>Unsweetened milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880</td>
<td>13,033,000 pounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890</td>
<td>37,926,000</td>
<td>214,518,000</td>
<td>280,278,000</td>
</tr>
<tr>
<td>1900</td>
<td>186,921,000</td>
<td>363,915,000</td>
<td>1,052,347,000</td>
</tr>
<tr>
<td>1920</td>
<td>494,796,000</td>
<td>1,416,262,000</td>
<td></td>
</tr>
<tr>
<td>1929</td>
<td>2,206,648,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The number of plants preparing milk and their distribution is as follows, these naturally being confined to dairy sections:

<table>
<thead>
<tr>
<th>State</th>
<th>1900</th>
<th>1920</th>
<th>1930</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>California</td>
<td>2</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>Colorado</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idaho</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>11</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Indiana</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Kansas</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Kentucky</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Louisiana</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maine</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maryland</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td>4</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Minnesota</td>
<td>2</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Missouri</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Montana</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nebraska</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>New Hampshire</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>New Jersey</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>New York</td>
<td>16</td>
<td>68</td>
<td>52</td>
</tr>
<tr>
<td>North Carolina</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Dakota</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio</td>
<td>30</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>3</td>
<td>37</td>
<td>39</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>1</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>South Dakota</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tennessee</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texas</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utah</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Vermont</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Virginia</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td>1</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>West Virginia</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>4</td>
<td>40</td>
<td>76</td>
</tr>
</tbody>
</table>

The preparation of evaporated milk is the most highly technical line in the canning industry. It has been subject to chemical control to a greater extent and for a longer time than any other product, and yet one can confidently expect greater improvements in the future. It has made more improvement since 1920 than in all the preceding years. Much secrecy has attended the factory operations in the packing, more than with any other product except meat, which has been a handicap, but with the inauguration of the present research upon fundamentals this condition will soon pass. The work requires special equipment differing from that of the usual can-
History

The value of milk in furnishing some important ingredient not supplied by other foods, especially for children and for warding off certain diseases, was recognized in Europe during the last half of the eighteenth century. Early in the nineteenth century the Society for the Encouragement of National Industry advocated the more general use of milk by the people to promote better health, and sought to stimulate interest in any suitable means for preserving it for use where fresh milk could not be obtained. It was wanted particularly on board sailing vessels carrying immigrants to this country as babies and young children became acute sufferers from the use of dried and salt cured foods; also on vessels used in exploration, men-of-war, and the like, as well as in the larger cities during the winter. English and French purveyors of foods vied with each other in trying to supply the want and especially for sea-going vessels.

M. Appert was the first to sterilize milk in bottles, and in order to economize in containers and volume, he evaporated milk to two-thirds its original bulk. The reduction of necessity was done in an open kettle, and one can readily understand that as a result of the high and prolonged heating necessary that such a strong cooked flavor resulted that the product was not acceptable for general use though it might be satisfactory for some cooking. He improved his work and submitted samples with other foods for tests by the navy in 1814. The description of the method in 1810 is as follows:

Milk. "Twelve liters of milk fresh from the cow have been taken, set in a water-bath and reduced to two-thirds of its volume, skimming it often. Afterwards it is strained through cloth; when cooled, the skin which had formed on it in cooling is removed, and the milk is put in bottles with the ordinary processes, and then in the water-bath for two hours' boiling, etc. At the end of some months it was noticed that the cream had separated in flakes and was floating on the surface in the bottle. In order to avoid this objection a second experiment was made with an equal quantity of milk which had been reduced in the water-bath by a half instead of a third, as in the first. I conceived adding to it, when it was reduced, eight fresh egg yolks diluted with the same milk. After having left the whole thus well mixed a half-hour over the fire, it was finished as in the former experiment. "This method has succeeded perfectly. The egg yolks had so thickened it all that at the end of a year, and even eighteen months, the milk was preserved as fresh as when I put it in bottles. The former was likewise preserved for two years and more; the cream which had formed in flakes disappeared on putting it on the fire, both of them tolerating the same heating. From both of them butter and whey were obtained; in the different experiments and chemical analyses to which they had been submitted, it has been recognized that the latter, truly superior, could replace the best cream that is sold in Paris for coffee."

Cream. "Five liters of cream, skimmed carefully from good milk, were concentrated without skimming to four liters in the water-bath, the skin which was formed on it was removed so as to strain the whole through cloth and put it to cool. After having again removed the skin that had formed in
cooling, it was put into half-liter bottles with the ordinary processes, so as to give it an hour's boiling in the water-bath. At the end of two years this cream was found as fresh as if it had been prepared that day. I have made good fresh butter from it in quantities of 4 to 5 ounces per half-liter."

WHEY. "I have prepared whey by the ordinary processes in practice. When it is clarified and cooled, it is put in bottles, etc., so as to give it an hour's boiling in the water-bath. However well clarified the whey may be when put in the water-bath, the application of the heat always separates from it some particles of cheese which form a deposit; I have kept it two or three years in this way, and before making use of it have filtered it so as to have it very clear. In case of haste, it suffices to decant it, to obtain it clear."

The foregoing description is of interest because it is the record of the first attempt to preserve milk in a hermetically sealed container by means of heat. It was the forerunner of what has since become a great industry. In 1811, Appert produced milk tablets, and later devised the temporary preservation of milk by heating for only a short time. This is described in the fourth edition of his work in 1831. The principle is the same as used in pasteurization but this latter did not come into general use until a number of years later. His fellow countryman, Malbec, concentrated milk with sugar in 1826. Other French workers were Jules Jean Baptiste Martin de Lignac who obtained an English patent on evaporated milk preserved with sugar, October 7, 1847; Grunaud and Galais, who in 1850 reduced milk to one-fourth its volume at a temperature not exceeding 30° C., and though not sterile, it kept for a time and was marketed in bottles; and Grimewade, who in 1856 prepared milk powder. De Lignac prepared both sweetened and unsweetened evaporated milk, but the technique was not sufficiently perfected to make it a commercial success.

The English showed partiality for preserving milk with sugar, the first patent being issued to De Heine in 1810, the heating in this case being done in an open vessel. The vacuum pan was invented three years later, May 20, 1813, by Edward Charles Howard, Brest-bourne Green, England, the patent number is 3754. This was not specifically designed for handling milk, but the possibilities in this direction were soon recognized. The first English patent to utilize the vacuum pan for the preparation of milk was granted to William Newton, March 11, 1835. The following is quoted:

"Patent right No. 6787. For preparing milk so it may be preserved for any length of time with its nutritive properties and capable of being transported into any climate for domestic or medicinal purposes. This being effected by adding to the milk a certain amount of sugar and evaporating it by any suitable means, using only gentle warmth to quicken the operation. It may be brought to the consistency of cream, honey, or soft paste, or even into dry cakes. Cocoa, coffee, or tea may be evaporated with it."

English patents along the same line were granted to Thomas Shipp Grimway, May 14, 1847, and to Martin de Lignac as already stated.

In this country in 1828, William Underwood prepared milk with sugar and bottled it but in no sense did he establish an industry.

The period from 1800 to 1850 may be regarded as one in which there was a groping after principles in the concentration and preservation of milk, but it remained for those of the second-half century to improve and
To Gail Borden befell the good fortune to make evaporated and condensed or sweetened evaporated milk a commercial success and the latter so that it could be kept and marketed under store conditions. The pecuniary reward in this instance seems to have been commensurate with the effort.

Mr. Borden was a passenger on a sailing vessel en route from England to this country in 1851, and observed the suffering among the small children because of the unsuitable food. The limited amount of milk was from seasick cows quartered and exposed upon deck, which upon ceasing to give milk were slaughtered for fresh meat. The passage ordinarily required four weeks or more with conditions so revolting that he determined to find some way to improve upon them.

He went to the Shaker community at New Lebanon, New York, presented the problem to them and began experimenting with the production of a preserved milk. Those people had a small vacuum pan which they used in making extracts and medicinal preparations, but which was available to him. In 1853 he applied for a patent upon concentrated milk produced in vacuo which was denied on the ground that it disclosed nothing new or novel, but upon reconsideration a patent was granted August 19, 1856. It is incorporated in full in this monograph for the reason that it is a landmark in the history of evaporated milk. Mr. Borden's success depended far more upon his appreciation of the need for absolute cleanliness in the production of milk, its quick handling from the barn to the factory, and the proper control of the temperature in evaporating and cooling than to any special apparatus. It was his system and skill which counted rather than any claims of invention, and in all the years which have elapsed there has been little deviation from the principles which he developed as they are fundamentally correct.

**Borden Patent**

Patent No. 15,553, issued August 19, 1856.

Be it known that I, Gail Borden, Jr., of the City of Brooklyn, in the County of Kings, State of New York, have discovered and invented a new and useful Process and Improvement for the Concentration and Preservation of Milk; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the annexed drawing, said drawing being a vertical view of the apparatus and forming a part of this specification, except the vessel marked “D”, which does not pertain to this application.

To enable others skilled in the art to make and use my invention, I herein describe its nature, office, and construction.

First. The nature of my discovery and invention consists in concentrating milk in a vacuum vessel out of contact with the atmosphere, to prevent incipient decomposition, or any hurtful change in the constituent elements of the milk during the process of evaporation.

Second. It also consists in keeping the new sweet milk to be concentrated, in vacuo, in a vessel from which the air is exhausted, to keep the milk out of contact with the atmosphere.

\[B\] is a vacuum-boiler or pan for concentrating the milk out of contact with the atmosphere.

\[A\] is a pipe connected with the vacuum-boiler and to an air-pump and condenser.

\[C\] is a vacuum-reservoir, in which new sweet milk is placed and kept in vacuum until it is required to be transferred or let into the vacuum-boiler \[B\] for concentration. This reservoir is connected with the boiler and with the air-pump.
The milk is boiled and concentrated in the vacuum-vessel $B$ by means of steam applied in the known way, and the application of the air-pump and condenser. When a steam-pipe is employed inside of the boiler, it should be so coiled that every part of it may be reached by the hand with a scrub-brush to clean it. Both steam-pipe and jacket may be employed at the same time. A thermometer is inserted into the boiler, and a vacuum-gage connected with it to indicate the temperature of the boiling fluid and extent of the vacuum.

The milk which I desire to concentrate is placed in the vacuum-reservoir $C$ as soon as practical after the milking, where it remains until let into the boiler for concentration. The milk may be scalded in this reservoir, or it should be done previous to its being put into it. By scalding the milk at a temperature of from 150 to 200, Fahrenheit, previous to its concentration, portions of its albumen coagulate and adhere to the surface of the vessel, and thus prevent its coating the vacuum-boiler. The vacuum is produced in the reservoir $C$ by the air-pump, through a pipe connected therewith, as $A$ and $C$.

$c$ is a cock to open and close the communication.

$C''$ is a pipe communicating with the reservoir and boiler.

$c'$ is a cock to open and close communication.

The reservoir is provided with a manhole for convenience of cleaning. It is charged with milk through a pipe leading to the can by means of atmospheric pressure.

The boiling or working of the vacuum-boiler is conducted in a similar manner to vacuum-pans in the manufacture of refined sugar in the common way, except that I find it best first to place a small quantity of milk in the boiler. I then (after the boiling has commenced) let the milk flow into the boiler from the reservoir by a stream gradually running in through pipe $C''$, regulated in quantity by the cock $c'$ in such a manner as always or during the principal part of the evaporating process to keep and maintain the fluid in the boiler $B$ at about the same consistence or state of spissitude.

The arrangement and position of the vessels employed may be made to conform with buildings in which they are placed.

To facilitate the operation of concentrating milk, so as to keep the vacuum-boiler constantly employed, I provide a vacuum receiving vessel below and in connection with the boiler, as $E$, in which I can at pleasure produce a vacuum by connecting pipe leading to the air-pump, a cock being provided to let on and shut off the vacuum, as $E'$ and $e''$. When the milk is sufficiently concentrated in the boiler $B$, it can be let into the receiving vessel $E$ by means of cock $e''$ without breaking the vacuum in the former.

Milk may be concentrated to any degree required. I do not confine myself to one standard. I have reduced it eighty-three per cent, but commonly sixty-five to eighty per cent.

For long keeping I place the concentrated milk in hermetically sealed vessels. For keeping a few days or weeks, according to the temperature of the weather, it is unnecessary thus to seal them.

The concentrated milk, having been cooled, is poured into the canisters or vessels, which are filled quite full, covered tightly, turned upside down, and deposited in a cool place.

I am aware that a vacuum-pan has long been used for the concentration of saccharine sirups and refining sugar, to prevent discoloration by a high degree of heat, and also employed in producing extracts to avoid scorching or burning. I concentrate milk in vacuum for a different purpose.

I have discovered that the water in milk can be expelled without changing the qualities of its other constituents if evaporated out of contact with the air by preventing the action of the oxygen on the milk while in the process of concentration, thereby preventing incipient decomposition or any hurtful change.

Like blood, milk is a living fluid, and as soon as drawn from the cow begins to die, change, and decompose. In no other process for concentrating milk with which I am acquainted has any adequate means been adopted to prevent incipient decomposition of the milk and render it preservative and soluble.

My milk is prepared for use by adding water in proportion to the degree of concentration to which it had been subjected, and when in this state will produce an equal quantity of cream with the original milk. It is rendered preservative and soluble without the use of sugar or any antiseptic, which has not, to my knowledge, ever been effected before.

Besides the advantages of concentrating milk in vacuum, there is no means yet discovered by which evaporation is so rapidly and safely conducted.
Milk concentrated by my plan can be afforded for less than half the price at which other concentrated milk has usually been sold.

My process will cause milk to become in as general and common use as sugar.

Having thus explained my invention, I would state that I am well aware that sugar and various extracts have been and are now concentrated in a vacuum under a low degree of heat to prevent discoloration and burning. I do not claim boiling milk and concentrating it in a vacuum-vessel for such purpose.

I am also aware that scalding milk to improve its preservative qualities has long been known, and that it has been kept in hermetically-sealed vessels. I do not claim these processes.

I am also aware that Wm. Newton and many others since have obtained patents for concentrating milk by various modes of evaporation and combining it with sugar to render it soluble and preservative. I do not claim this as my discovery, or invention; but;

What I claim, and desire to secure by Letters Patent, is producing concentrated sweet milk by evaporation in vacuo, substantially as set forth, the same having no sugar or other foreign matter mixed with it.

Mr. Borden obtained subsequent patents: Re-issue No. 1,306, May 13, 1862; No. 35,919, July 22, 1862; Re-issue No. 1,398, February 10, 1863; Re-issue No. 2,103, November 14, 1865; and Re-issue No. 2,226, April 17, 1866. The matter pertaining to preheating or forewarming is best stated in the last patent, and the following paragraphs are quoted:

The nature of my invention will be best understood by attending to the following considerations concerning the subject to which it relates. Milk, like blood, is what may be termed "a living fluid"; that is to say, the sources from which it is derived, whether animal or vegetable, are always found possessed of vitality, and in this life it seems to participate so long as it remains connected with the bodies which produce or contain it, while as soon as it is separated from them it begins to undergo change and die. All organic substances are injuriously affected by the atmosphere, and are liable to reaction among their constituent elements; hence the deterioration of milk is greatly influenced and accelerated, though not wholly caused, by exposure to air. It is doubtless for these reasons that nature provides means for transferring the milk of animals to their young by causing it to pass through a vacuum. This demonstrates that the less milk is suffered to be acted upon by the external air, the better is its condition, and this fact has suggested the first portion of my improved process, and has led me to perform the concentration, which is one object of my invention, in such a manner as to exclude the milk as much as possible from contact with the atmosphere while it is being concentrated; and for this purpose I cause the concentrating process to be performed in a vacuum-pan in the mode hereinafter described.

Crude milk, that is, milk in its natural state as it comes from the animal furnishing it, contains among its constituent elements caseine and albumen, the albumen being combined with the caseine. When milk is brought into contact with a surface which is at a temperature of, say 145° to 150° Fahrenheit, or thereabout, this caseine, and probably the albumen also, will commence to burn, and when so burning will "bake" or "stick" onto any such surface, and form a coating, which will constantly increase in thickness if the burning continues, and which is almost absolutely impenetrable to heat. In order, however, to render the operation of concentrating milk in a vacuum-pan sufficiently rapid and economical to be of practical value, it is necessary that the metal of the pan and of the coil (if a coil be used) should have a higher heat than the 145° to 150° above mentioned; but if such higher heat is employed the caseine of the milk at once begins to burn, and it will then so bake and coat onto the inner surface of the pan and the outer surface of the coil that, for the reason already stated, the conduction of the heat to the milk soon stops or nearly stops, and the concentration can no longer be carried on to any practical or desirable extent. Moreover, it is extremely important to retain the caseine and the albumen combined with it on account of the highly nutritious properties of each of these substances, and their baking to the hot metal deprives the milk of the greater portion of them and seriously injures the quality of the charge in the pan, besides imparting to it a very disagreeable burned taste. On the other hand, if the degree of heat in the metal is employed lower than that at which burning of the caseine will take place, the operation of concentration will be made so slow and tedious as to be useless for practical purposes. These are the difficulties which render valueless all the processes for concentrating milk which were.
so far as I am aware, proposed before my invention, and they are the difficulties which I was compelled to encounter in perfecting my improved process.

From what has been said respecting them, it is manifest that it is indispensable to provide proper means for preventing the baking or coating of which I have spoken, and to this relates the second portion of my invention. To accomplish it, I, after long-continued experiments, ascertained that if the milk to be concentrated be heated before it is run into the vacuum-pan, the coating will be entirely obviated. This result I have, until recently, ascribed to what I supposed was the fact: namely, that it was the albumen contained in the milk which, by being coagulated by the heat in the vacuum vessel, was precipitated upon any surface exposed to it, and thus formed the coating, and that by the preliminary heating of the milk the greater portion of its albumen was coagulated away from the pan, so that no further injurious precipitation would be produced by the subsequent heating in the vacuum process; but since my patent was last re-issued, on the 14th of November, 1865, I have ascertained that this supposition was probably erroneous, and that it is simply the burning of the casein, or of the combined casein and albumen, which causes the coating, and that the manner in which my preliminary heating operates to prevent the "baking" or "sticking" of the milk is by raising the temperature of the latter sufficiently high before it is introduced into the pan to enable it to boil instantaneously or very quickly after such introduction, by reason of the well-known fact that the boiling-point of a liquid in a vacuum is much lower than in the atmosphere, because in a vacuum the pressure of the atmosphere is removed, and also by reason of the fact that when milk in a vacuum-vessel once comes into a state of ebullition or agitation, little or no coating will take place, probably because the casein, by being constantly in motion, cannot adhere to the hot surfaces and be burned.

It is upon these two principles that my improved process is based; that is to say, upon evaporating the milk away from the atmosphere, and upon the preliminary heating of it out of the vacuum-pan, and to enable those skilled in the art to which my invention relates, I will proceed to describe it in detail.

The thing which I have invented is the process itself, and the working of this is in no way dependent upon any particular form of apparatus.

The milk to be concentrated in a vacuum is first to be heated, and I prefer that this heating should take place as soon as practicable after the milking. It may be performed in the reservoir C, or in any other suitable vessel, and the heat may be applied in any convenient manner. The temperature which I have employed for this preliminary heating is from 150° to 200° Fahrenheit: but I do not confine myself to any specific temperature so long as the milk is heated sufficiently to enable it to boil instantaneously or very quickly after it is let into the vacuum-pan A, it being the preliminary heating itself for this purpose, and not any particular temperature, which constitutes the gist of this part of my invention.

Mr. Borden had very little money, and after obtaining his first patent he went to Walcottville, now Tarryton, Connecticut, where about two thousand dollars were raised to fit out a factory and launch the business of evaporating milk. This was in 1856, but before the plant was fairly in operation the subscribers lost faith in the enterprise, the project was abandoned, and he was left penniless. The next year he organized another company at Burrville, five miles distant from the first, and there converted a small old mill into a condensary. The work was started under great difficulties as the country was suffering a financial panic and money was not obtainable for any purpose. The factory was not operated continuously but enough milk was produced to establish its merits. In 1858, he was fortunate in obtaining financial assistance, the business increased, and within a couple of years it was found necessary to move to a point where there were direct transportation facilities to New York City. The new factory was opened in Wassic, New York, in the summer of 1861, two months after the outbreak of the Civil War. The entire output was commandeered for the use of the army, and later the building of other factories was necessary to supply the added needs. At least five plants were in operation before the end of the conflict. The milk proved so satisfactory in hospitals and in the field that it became known throughout the country, and doubtless this had much to
do with the prompt establishment of the industry. In 1865, David S. Page produced condensed milk at Cham, Switzerland, following the method developed by Mr. Borden, and the following year the Anglo-Swiss Condensed Milk Company was organized and took over the operation, and has ever since been the outstanding success in Europe.

The first milk packed by Mr. Borden was plain evaporated milk, not sterilized but sold in bulk from ten-gallon cans in New York City. The milk retailed at twenty-five cents a quart, but had the advantage of smaller bulk, could be diluted from two to five times, and, furthermore, would keep longer than fresh milk. This latter quality was doubtless due to the heavy concentration which evidently was carried to about one-fourth that of the fresh milk. Some of the accounts state that the packing of sweetened evaporated or condensed milk was made as early as 1856, but his first patent and those which follow are for milk prepared without the addition of sugar. Whatever the correct date may be, he was the pioneer in that line and from that line he attained his greatest success. Unsweetened evaporated milk could be kept for only a short time, whereas the sweetened could be packed in small cans for domestic use and in larger containers, even barrels for large users, and kept for a long time. The high sugar content gave it preservative qualities. This is the form of prepared milk known to consumers prior to 1885, and is still manufactured, though in relatively small quantity by comparison with sterilized evaporated milk.

**Sterilized Evaporated Milk**

The second step, the production of sterilized, unsweetened, evaporated milk was accomplished by cautiously feeling the way. Johannes Nevens Chawnder is credited with preparing milk in 1856 and 1857 which remained sound. An English patent was granted to Joseph House, January 1, 1857, for preserved, unsweetened, evaporated milk, who produced some milk on a commercial scale, but the product was seriously injured by the heating. No other work is recorded again until 1881 to 1883, at which time experiments were made in both Switzerland and Germany to preserve milk without sugar. A paragraph from Fleischmann's work, "The Dairy," is illuminating:

"Shortly after the method introduced by Shreff for the sterilization of milk had become known, the idea was carried into effect by rendering the condensed milk capable of being kept by sterilizing it, and thus dispensing with the addition of sugar, which by imparting to it a very pronounced sweet taste, rendered it disagreeable to many people. For this purpose ex-
Experiments were carried out during the years 1881 and 1883 in different parts of Germany and Switzerland. Sterilized, condensed milk was best obtained by purifying the fresh milk by the application of centrifugal force, then boiling it in order to coagulate the albuminous part of the nitrogenous matter. This was condensed in vacuum pans to a third or fourth of its original volume, and poured into metal vessels of the same shape and size as were used in the factory at Cham. The vessels, after being filled and soldered, were placed for a short time at a temperature of about 120° C., the keeping quality of the substance being tested by submitting it for a few weeks to a temperature of from 30° to 40° C., and after that lapse of time seeing whether there were indications of fermentation shown by distention at the bottom or the top of the vessels.

"If it be neglected to heat up the milk before it is condensed, the albumin is coagulated during the sterilization, which renders the contents of the can lumpy."

"If the preparation of condensed milk, without addition of cane sugar, is carried on with the necessary precautions, the product obtained possesses great keeping properties, and when dissolved in a suitable quantity of pure water, yields a liquid possessing all the properties prized in fresh milk, which, indeed, leaves little to be desired."

It is at this point that John B. Meyenberg becomes an interesting figure. He served an apprenticeship with the Anglo-Swiss Condensed Milk Company at Cham, Switzerland, and not being content to follow the routine through blind faith, conducted many experiments in packing unsweetened, evaporated milk during the period from 1880 to 1883. When he was reasonably certain that he had found the proper method, he laid the facts before the company, but received no encouragement for his pains. He therefore decided, though reluctantly, to come to this country where he believed the opportunities to be better. He arrived early in the spring of 1884, immediately applied for a patent which was granted promptly on November 25 of the same year.

He went to Illinois, and there became associated with the Helvetia Milk Condensing Company at Highland, superintended the making of the special machinery needed for his process, operated it, and on June 25, 1885, packed the first sterilized unsweetened milk in this country. That date marks not only the birth of a new industry which has become one of great importance, but also the application of a new principle in canning, the agitation of the cans while being treated, and which has since been extended to many other foods. He disclaimed invention of this feature, but its application is the most important single step in the industry since the invention of the retort.

The first milk prepared by Mr. Meyenberg was not perfect, and it required much time and experience to learn the limitations in handling milk under various conditions, the influence of feed, season, and other factors which affect it to a greater or lesser degree. But as experience was acquired, it was found that the fundamentals were correct, so the method was universally adopted and only recently has been modified to become a continuous instead of a batch process.
Meyenberg's Patents

Patent No. 308,421, November 25, 1884, is as follows:

Be it known that I, John Meyenberg, of the City of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Apparatus for Preserving Milk, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, and in which—

Figure 1 is a side view of the condenser. Figure 2 is a longitudinal section of the same. Figure 3 is an end view. Figure 4 is a transverse section taken on line 4, Figure 2. Figure 5 is a similar view taken on line 5 5, Figure 2. Figure 6 is a similar view taken on line 6 6, Figure 2.

The milk is put into cans of desired sizes, which are hermetically sealed and placed in frame H (see Figures 2 and 5), which consists of bars connected by heads H'. This frame is enclosed by a cylinder, I, held in supports I'. One end of the frame is supported within the cylinder on friction-rollers J, journaled in one head of the cylinder (see Figure 2). The other end of the frame is supported on one end of a driving shaft, L, passing through the other head of the cylinder. The outer end of the shaft is supported in a journal-box, M, on a standard M'. On this shaft are two loose driving pulleys, O O', one of them being large and the other small, and both of them being provided with notches or teeth O, to engage a sliding clutch, P, arranged to turn with the shaft. Both pulleys are provided with driving-belts, and by connecting one or the other of them to the shaft by the sliding clutch the frame H may be turned fast or slow, as desired. The frame H can be removed from the cylinder, to be filled with cans, through an opening which can be closed by a door, Q, held in place by a swinging frame, T, and a screw, T'. The interior of the cylinder may be heated by steam passing through pipe or pipes U, and may be cooled by air entering through pipes V. Before the cans are placed in the frame H they are immersed in water and the milk cooled to a temperature of about 35°. The milk may be put into open cans and cooled off and then be put into tight cans, as stated. The tight cans should not be quite filled with the milk, so that the milk can move when the frame H is turned. It is better that the cans should have very little, if any, contact one with another in the frame H. When the cans are put in the frame and the cylinder closed, the frame being supported within the cylinder, as shown in Figure 2, steam is admitted to the pipe or pipes U, heating the interior of the cylinder. The frame is simultaneously turned slowly, about two or three revolutions per minute. This is continued about thirty minutes (the temperature should not exceed 218° to 228°), and then the steam is turned off and the pipe or pipes U cooled by water being passed through them or it. At the same time air is admitted to the interior of the cylinder through the pipes V. The frame is then turned quickly for fifteen minutes, more or less, during which time the milk is cooled to a temperature of 25° or 30°. The cans are then taken out and examined to see if there is any leakage, which will show whether or not they were hermetically sealed. The cans can then be stored away and the milk will keep good for years.

I claim as my invention—

1. The combination of the revolving frame adapted to receive cans, the outer enclosing-cylinder, and the air and steam pipes, arranged and operated substantially as and for the purpose set forth.

2. The combination of the revolving frame H, cylinder I, surrounding the frame, steam-pipes U within the cylinder beneath the frame, air-pipes entering one end of the cylinder, and a door at the other end of the cylinder, through which the frame passes, as set forth.

Patent No. 308,422, issued November 25, 1884:

Be it known that I, John Meyenberg, of the City of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Process of Condensing Milk, of which the following is a full, clear, and exact description.

In carrying my invention into effect, I heat the milk as it comes from the cows with steam out of contact with the milk, the milk being stirred and exposed to the air until about one-sixth of its volume is evaporated. Next the milk is cooled out of contact with the air by cold water, while the stirring is continued, the milk, of course, being out of contact with the water. Next, all vapors and air that might be generated are withdrawn from the milk by exhaustion. This operation prevents all changes or the formation of germs of fermentation. The milk is next cooled down to from 100° to
John B. Meyenberg was born in the village of Zug, Switzerland, November 13, 1847, and was fortunate in receiving a much better education than most men of his time. This was largely due to his innate desire for knowledge and taking advantage of every opportunity that presented itself. His liking was especially along the line of science, which stimulated accurate observation, and he was skilful in the use of tools, both of which traits stood him in good stead when he became older and was serving an apprenticeship in a milk condensary. It was while working in the factory at Cham that he became convinced that evaporated milk could be preserved the same as other canned foods if only the right combination for the treatment be worked out. Sweetened milk was very costly on account of the sugar which it contained and, furthermore, was unsuitable for many purposes. Plain, evaporated milk appealed to him as having much greater possibilities and wider uses.

Others, following the precedent which he had set, developed machines which varied in mechanical details, permitting greater capacity, easier loading and unloading, etc., but preserved the principle. Great secrecy was also maintained with regard to the handling of these retorts, whether the cans were turned continuously or interruptedly, the speed of agitation, the rate at which the temperature was brought up, the time of holding, and the rate of cooling after the cooking period was over. In the development of the continuous system of sterilization, it was necessary to closely approach the treatment of the milk as recorded in the Meyenberg process.
Production of Milk

The canning of milk begins with the production upon the farm under supervision of the factory management for without a constant supply of clean milk of uniform quality an acceptable evaporated milk cannot be placed upon the market. The chances of success from using milk from all breeds, produced by methods which each farmer or dairyman might see fit to adopt would be about as certain as that of a fruit packer to use cling and freestone peaches together, or Bartlett, Keifer, and Seckel pears in the same can, and expect a satisfactory product. This phase of milk canning is so important that more and more of the factories are owning an interest in herds or make their contract with producers on the basis that the company shall have advisory supervision of the breeding, feeding, and housing conditions of the herds as well as of the handling of the milk prior to the time it arrives at the factory.

Breed

The breed selected for milk production is generally the Holstein or grades with Holstein influence predominating. This breed produces a large volume of milk, and while it is not as rich in butter-fat as that of the Jersey and some other breeds, it is somewhat better adapted for evaporating. Butter-fat is not as important in this case as in milk for the fresh market or for butter-making since in this case the percentage of fats and solids are standardized during evaporation and before canning. As a matter of fact, the effect of concentrating Holstein milk is to produce one with higher total solids when diluted than is the average market milk. Besides being a large milk producer, the Holstein is a healthy rugged animal capable of adapting itself to varying conditions.

Housing

The housing of the animals in inclement weather and for feeding and milking is imperative, and it is essential that provision be made for the cleanliness of the animals and comfort of those who have to work with them. Cleanliness is placed first for the reason that proper initial construction of the stables affects the labor three hundred and sixty-five days in the year, and may affect the quality of the milk in some degree during the same time. The conditions which make it easy or difficult to keep the cattle and quarters clean indirectly have their effect upon the help in fostering care or not encouraging it, thus good sanitary conditions yield a continuous return upon the investment. The sanitary requirements have been studied and construction standardized so that recommendations are incorporated in bulletins and texts intended for the guidance of dairymen. The matter of the comfort of the animals and attendants is placed second for the reason that neglect in this regard is quickly reflected in the yield of milk and, therefore, will bring about a proper correction.

Feed

While theoretically it might seem that the matter of feed would have an insignificant effect upon mixed herd milk, it has been found practically that it is desirable to have the milk supply obtained from a limited area and the conditions be fairly constant for all the herds. Dry feed, fodder, silage, pasturage, and commercial mill feeds each have some effect, and the slight manipulations of the milk made necessary by these factors can be
done best when the herds are being handled in a similar manner. It is need¬
less to add that feeds imparting a disagreeable odor or flavor or otherwise
affecting the normal qualities of the milk must be rigidly excluded. A much
wider latitude in the use of foods can be tolerated in milk production for
butter and cheese than for evaporated milk.

An innovation that is attracting attention is to have a large proportion
of the cows freshen late in the fall and produce their heaviest milk flow
on dry feeds. Other factors which enter are a more uniform supply of
milk throughout the year and a lesser cost for labor during the winter than
in the summer.

Since a factory packing only 750 cases of milk per day, which is not a
large factory, requires about 82,000 pounds of milk per day or the product
of 3,000 cows, it is apparent why the matter of breed, feed, and physical
surroundings become such important factors that contracts must include
their supervision by the factory.

Inspection

The production of milk requires inspection of the herds for general
diseases, particularly tuberculosis, and the individual animals for cases of
mastitis or other local infections. These require the services of a veter¬
arian, and is done more efficiently by the company than by the dairyman.
The impression is sometimes given that because the milk is sterilized in the
canning that more laxness is tolerated than with fresh milk, but the facts
are the contrary. The large investment in the milk plant and business and
the ease with which criticism is spread would make any operator hesitate
to take a chance even if he had no higher moral sense of right than profit
from sales.

In like manner the milk plant conducts its own inspection of the equip¬
ment and mode of handling the milk at frequent intervals, much more fre¬
quently than required by city or state regulations affecting the fresh milk
supply.

Milking

The milking is done at regular intervals of as nearly twelve hours as is
practical. If one period be longer than the other, it is most often the night
period. The work needs to be done in a manner to insure the greatest de¬
gree of cleanliness. The flanks and udder are wiped with a moist cloth to
remove loose dirt and hairs, and the hands are washed just before begin¬
ning the milking. Discarding the first ounce from each quarter has the
effect of cutting down the bacterial contamination, and is considered advan¬
tageous for milk held over night where cooling cannot be carried as low
as may be desirable. Where hand milking is followed, the pails have the
tops covered over fully two-thirds of the area in order to reduce con¬
tamination as much as possible. The attempt is made to draw out all the
milk as the opposite practice results in decreased production and shorten¬
ing of the period of lactation.

Milking machines have been developed to the point where they perform
the burden of the labor, but in most cases are aided by hand stripping as
a final operation. The cleaning and sterilizing of the machines becomes an
important operation in this instance.
The milk is taken from the stable to the milkroom, and there strained into sterile cans and set into cold water to remove the animal heat. The object is to get the milk below 50° F. if practicable, and especially if the milk is to be held over night. As most dairies have to depend upon well water for cooling, it is often impossible to reach this temperature and refrigeration or ice supply is not generally available upon farms. Formerly the milk was run over coolers and the method is still very generally used. These coolers were most often made up of a series of narrow, hollow shelves, with cold water circulating through the inside while the milk, being distributed over the outside in a thin film, gave up its heat and animal odor. The objection to the apparatus is the difficulty in keeping it perfectly clean and bacterial infection of the milk may be greater than the retarding effect of the cold. The light speed wagon or truck is affording the solution for this problem in many places, the milk being taken to the factory within a few minutes after it is drawn, twice a day, and the cooling done there under much lower temperatures than is possible on the farm. Without doubt this method will become more general in the future, the incentives being economy, convenience, and betterment of the product. The new type of unit refrigerating plants is finding a place on the larger farms which are long distances from the evaporating plant.

When only one delivery is made each day, the morning and evening milkings are kept separate.

The methods of sterilizing the milking equipment on the farms and the cans used in delivery have been the subject of numerous investigations and the results published in experiment station bulletins.

Contracts
The business side requires that contracts for milk cover the entire year and provide for seasonal variation in the rate of payment. At present the fluctuations are with the price of butter-fat though that factor is of less importance in this product than in milk for butter-making.

Substance of Contract Requirements
Cows. The milk must come from healthy cows. Milk from cows that are diseased, or that have a diseased udder, or that are otherwise in poor condition, will be rejected.

Feed and Water. Do not feed weeds, roots, or other feedstuffs possessing strong and obnoxious odors, such as onions, garlic, turnips, cabbage, wet distillery slops, decayed, musty or sour silage, or other fermented feed.

Lactation Period. Reject all milk from cows less than thirty days before, and seven days after calving.

Milkers and Milking. Milk with clean dry hands into clean utensils and remove the milk to the milk room immediately after drawn.

Straining. Strain the milk in the milk room through a fine wire mesh strainer (80 to 100 meshes to the inch). Do not use cloth strainers.

Cooling. Cool the milk to 60° F. or below and keep it at that temperature until it reaches the factory. Do not mix the warm morning’s milk with the cold night’s milk; cool the morning’s milk before mixing, or send it to the factory in separate cans.
Care of Utensils. Rinse with cold water, wash with warm water and washing powder, and rinse with boiling water all milk utensils thoroughly after use; keep them in a clean place between milkings, where they are exposed to air and sunlight. Do not store the milk on the farm in cans that have not been washed at the factory.

Stable. Whitewash the stable twice every year and remove manure daily. (Some condenseries furnish spray pumps for applying whitewash.)

Receiving the Milk

The standard method of delivering the milk is in eight- or ten-gallon cans properly protected from the extremes of temperature. The milk from each patron is weighed separately and this applies also to night and morning milk in some places. Each can has the cover removed and either the cover or the can is smelled by the inspector. This is the quickest and simplest test that can be applied, and if the inspector has been properly trained, the test is as sensitive to souring or other conditions in the milk as sight is in the detection of rot in fruit or vegetables. In cases of doubt, taste may be used, or the chemical test for acidity and even bacteriological examination. Bacteriological examinations either direct or by culture are too slow to have a general use in routine examination, but are often of use in locating troubles when other methods fail. The acidity test serves as a check against the personal factor.

Samples of the mixed milk are taken for butter-fat tests to be used at once or to become part of composite samples covering 10, 15, or other number of days as desired. The factory learns from its field inspector and from experience how detailed the tests must be. The laboratory tests are a necessity both as a guide for the fair payment to the customers and to insure the plant turning out a high-class product.

After weighing the milk, it is strained into batch tanks and at this point it would seem better that the milk be run through a clarifier to remove material which cannot be taken out by the ordinary strainer. The fact that such material cannot be seen in the finished product and that clarification is not required in market milk is not a valid excuse for following the same custom, especially when apparatus is available to do the work. It is of much more importance than the manipulation of the milk to produce a certain appearance as a heavy body.

The batch is next tested for fats and then adjusted so that when evaporated 2.2 to 2.25 parts to 1, it will have 7.8 per cent of fat. The adjustment is made by adding cream or skimmed milk as may be required. If the milk tests very close to 3.5 per cent butter-fat before evaporation, the amount of adjustment is small, as this is close to the average herd milk. The 7.8 per cent of fat is the minimum requirement in evaporated milk to comply with the Federal Pure Food Regulations, but there is nothing to prevent a manufacturer exceeding that amount. It would seem logical to also make the adjustment for solids at this point but it is usually deferred until after the evaporation in the pan.

The batch tank may be set on a scale in order to have a direct and accurate weight, or dependence be placed on the weight as dumped. A second check is by the volume as shown on the side tube. Formerly the practice was to test for acidity and make the necessary correction. The more recent practice is to defer this until after the evaporation. Some compromise by
making a partial correction at this point and the final after evaporation. Customer acidity tests, however, are made upon mixed herd lots as delivered in order to locate any carelessness on the part of the producer. The method will be outlined after evaporation.

Forewarming

Forewarming or preheating is done as quickly as possible after the batch has been standardized for fats. Promptness in this detail arrests the growth of organisms and prevents increase in acidity. This step was first employed by Gail Borden but for the purpose of preventing the milk sticking to the heating surface of the pan. It has another important function in that it controls to a considerable extent the coagulation of the milk in the subsequent sterilization. This was learned by Meyenberg who not only used a boiling temperature but kept it up for a sufficient time to evaporate about one-sixth of the volume. Later, as other factors became better understood, this was modified, using less heat to obtain the result.

Within certain limits, the more heat that can be applied here, the less danger of coagulation of milk in the can, and without forewarming this is certain to occur. L. A. Rogers and his associates in the Dairy Division of the Department of Agriculture found in their experiments that the maximum temperature in this operation should not exceed 203°F., and that while holding the milk at this point for twenty minutes raised the coagulating point to 257° as compared with 246.2° without holding and 251.6° after holding for ten minutes, other considerations make it desirable to keep the time as short as possible. In practice, the range of temperature used is from 190° to 210° F., and the time from 5 to 10 minutes, ascribed to seasonal variations due to feed, period of lactation, etc., and to the experience of the operator. The time factor is determined by test cans made daily or at short intervals as the need for any changes may be anticipated in this way.

Forewarming has the beneficial effect of eliminating odor from the milk, and still others of greatly reducing the foaming in the pan and the tendency to stick on the coils. The serious objection is the darkening which it produces in the color. Milk carried to 200° F. and held for any considerable time browns or has a distinct cooked appearance. The fresher and cleaner the milk, if well cooled after milking, the lighter may be the forewarming and thus preserve the natural color.

The latest method of preheating is to draw the milk swiftly through steam jacketed tubes so that the heating is done in a flash and then the milk discharged into the holder tanks. Formerly, preheating was done, and still is in the smaller plants in jacketed kettles or in glass-lined tanks with a coil. In either of these batch methods, it is desirable to have an agitator in the tank to make a forced circulation and thus avoid the milk sticking on the heating surface. Another practice still used in some places is to discharge steam into the milk with the result that the steam is condensed and has to be evaporated again in the pan, obviously not a logical procedure. The added water which must subsequently be evaporated from such practice is shown in the following table.

Pounds of condensation water added per 1,000 pounds of milk through direct heating with live steam at 100 pounds pressure.
TABLE No. 1. NO PREHEATER USED

<table>
<thead>
<tr>
<th>Temperature of Milk</th>
<th>Hotwell Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>119.6</td>
</tr>
<tr>
<td>45</td>
<td>115.59</td>
</tr>
<tr>
<td>50</td>
<td>111.56</td>
</tr>
<tr>
<td>55</td>
<td>107.52</td>
</tr>
<tr>
<td>60</td>
<td>103.45</td>
</tr>
<tr>
<td>65</td>
<td>99.38</td>
</tr>
<tr>
<td>70</td>
<td>95.34</td>
</tr>
<tr>
<td>75</td>
<td>91.32</td>
</tr>
<tr>
<td>80</td>
<td>87.31</td>
</tr>
<tr>
<td>85</td>
<td>83.32</td>
</tr>
<tr>
<td>90</td>
<td>79.34</td>
</tr>
<tr>
<td>95</td>
<td>75.34</td>
</tr>
<tr>
<td>100</td>
<td>71.32</td>
</tr>
<tr>
<td>105</td>
<td>67.33</td>
</tr>
<tr>
<td>110</td>
<td>63.34</td>
</tr>
<tr>
<td>115</td>
<td>59.35</td>
</tr>
<tr>
<td>120</td>
<td>55.36</td>
</tr>
<tr>
<td>125</td>
<td>51.36</td>
</tr>
<tr>
<td>130</td>
<td>47.37</td>
</tr>
<tr>
<td>135</td>
<td>43.31</td>
</tr>
<tr>
<td>140</td>
<td>39.32</td>
</tr>
<tr>
<td>145</td>
<td>35.33</td>
</tr>
<tr>
<td>150</td>
<td>31.34</td>
</tr>
<tr>
<td>155</td>
<td>27.35</td>
</tr>
<tr>
<td>160</td>
<td>23.36</td>
</tr>
<tr>
<td>165</td>
<td>19.37</td>
</tr>
<tr>
<td>170</td>
<td>15.37</td>
</tr>
<tr>
<td>175</td>
<td>11.38</td>
</tr>
<tr>
<td>180</td>
<td>7.38</td>
</tr>
</tbody>
</table>

Where steam pressure is used under 100 lbs., corrections are as follows:

Add .08-lb. water for every 10-lb. reduction in pressure from 100-lb. to 70-lb.
Add .12-lb. water for every 10-lb. reduction in pressure from 70-lb. to 40-lb.
Add .17-lb. water for every 10-lb. reduction in pressure from 40-lb. to 10-lb.

TABLE No. 2. PREHEATER USED

<table>
<thead>
<tr>
<th>Preheater Temperature</th>
<th>155</th>
<th>160</th>
<th>165</th>
<th>170</th>
<th>175</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27.14</td>
<td>27.24</td>
<td>27.35</td>
<td>22.86</td>
<td>18.33</td>
<td>13.78</td>
</tr>
<tr>
<td></td>
<td>31.70</td>
<td>31.85</td>
<td>32.01</td>
<td>22.97</td>
<td>18.33</td>
<td>13.78</td>
</tr>
<tr>
<td></td>
<td>36.32</td>
<td>36.41</td>
<td>32.01</td>
<td>22.97</td>
<td>18.33</td>
<td>13.78</td>
</tr>
<tr>
<td></td>
<td>40.97</td>
<td>41.17</td>
<td>32.01</td>
<td>22.97</td>
<td>18.33</td>
<td>13.78</td>
</tr>
<tr>
<td></td>
<td>47.51</td>
<td>47.81</td>
<td>32.01</td>
<td>22.97</td>
<td>18.33</td>
<td>13.78</td>
</tr>
<tr>
<td></td>
<td>50.32</td>
<td>45.89</td>
<td>32.01</td>
<td>22.97</td>
<td>18.33</td>
<td>13.78</td>
</tr>
</tbody>
</table>

Evaporation

Evaporation is always conducted in vacuo in order that the reduction may be made at a low temperature and thus conserve to the maximum degree the quality of the milk. Because the work is conducted at a low temperature, it is thought that it requires less heat to effect the operation in this way, but theoretically it requires as many heat units to evaporate a pound of water under one condition as the other while practically, owing to certain mechanical features, it requires more coal to evaporate a pound of milk in a vacuum pan than in the open.

The usual vacuum pan or evaporator consists of a closed vessel, the lower half of which contains the heating units, such as steam jacket, coils, or tubes, and the upper part a chamber for receiving the vapor and from which it is drawn into a condenser, or in some cases the condenser may be installed within the top of the dome. The condensing element may consist of a simple jet of water discharging into a pipe having a fall of at least thirty feet and opening into a body of water, or the vacuum may be created by a pump. In practically all cases water is introduced into the system in order to absorb and condense the vapors and thus reduce their volume. In the condenser proper, the cooling surface is spread out as much as possible in order to increase the efficiency of the apparatus.

The amount of water required for condensing is about 100 gallons per case under good conditions, or two gallons per pound and in localities where the water is warm it may reach three gallons per pound. Evaporated milk requires the use of more water than that of any other canned product.

The apparatus is in reality very simple for effecting evaporation at temperatures below that which is normal at atmospheric pressure; that is, approximately 15 pounds per square inch at sea level. It has been known for a long time that if the pressure be reduced, the boiling point is likewise lowered and if the pressure be increased, the boiling point is raised correspondingly. The apparatus is, therefore, a heavy sealed container within
which the conditions can be controlled, or at least within the range found desirable for handling food products. The apparatus had its first practical application in the manufacture of pharmaceuticals and later was adapted to the manufacture of sugar, milk, and other foods.

While vacuum pans are made in many sizes adapted to the volume of material to be handled, the common form and the one most nearly standardized for the milk industry is six feet in diameter with from 150 to 200 square feet of heating surface, depending upon the arrangement of the heater used. The greater the heating surface, the higher the heating capacity but a limit is reached particularly in the coil type in the difficulty in getting at and cleaning the surfaces. The cleaning has to be done by hand, and if the coils be too close together or too near the jacket, the job is made so difficult that it is frequently not done well.

Much stress has been placed upon the arrangement of the coils and shape of the bottom of the pan as affecting the rapidity of the circulation, but recent studies upon the circulation of the milk due to the effect of the heat are changing the design, and mechanical devices are also being used to obtain higher results from the heating units.

All evaporators installed prior to 1920 operated upon the batch principle. Milk was drawn into the pan and evaporated, all that could be handled at one time constituting a batch. It is evident that the first milk entering the pan received a very much longer cooking period than the last. In the late type, the milk is drawn in continuously and also drawn off continuously at a rate which corresponds to the ratio of evaporation desired. The drawing off is into a tank attached to the same vacuum system as the pan. In this system there is no stoppage in the working of the pan from the beginning to the close of the day’s work, and thus the operation is simplified and much time saved.

Operation

The pan is closed and the water jet opened or the pump turned on to create a vacuum and then milk drawn into the pan until the heating surface is completely covered before steam is turned into the heater, otherwise the surface will be heated and the milk baked or burned on as soon as it touches it, not only interfering with the subsequent heating by the pan but also imparting a scorched taste to the milk as well. If coils be used, steam may be turned into the lower one as soon as it is covered, and then successively as the others are covered. Water is turned into the condenser at the same time so that any vapors arising from the warm milk are carried off. The milk foams at first, but ceases as the entrained air and vapor are released. The foaming is also increased if bicarbonate of soda be used in neutralizing the acidity in the preheater and this is given as one of the reasons for not neutralizing in the initial stage of preparation. During the filling, the operation of the pan has to be watched and the vacuum regulated to prevent carrying milk over into the condenser. Milk is constantly admitted from the hot well to replace the moisture carried off by evaporation and the rate regulated so that the heating surface is always covered. Reducing valves are used between the steam line and the evaporating pan to maintain a very nearly constant temperature upon the heating surface irrespective of irregularities in boiler pressure.
RELATION OF BOILING POINT TO PRESSURE
Expressed in Both Common and Metric Terms

<table>
<thead>
<tr>
<th>Boiling Point</th>
<th>Absolute Pressure</th>
<th>Metric Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inches</td>
<td>Pounds</td>
</tr>
<tr>
<td>212</td>
<td>29.92</td>
<td>14.697</td>
</tr>
<tr>
<td>210.2</td>
<td>28.50</td>
<td>14</td>
</tr>
<tr>
<td>209.56</td>
<td>26.47</td>
<td>13</td>
</tr>
<tr>
<td>208.4</td>
<td>24.43</td>
<td>12</td>
</tr>
<tr>
<td>206.6</td>
<td>22.40</td>
<td>11</td>
</tr>
<tr>
<td>205.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>20.36</td>
<td>10</td>
</tr>
<tr>
<td>199.4</td>
<td>18.32</td>
<td>9</td>
</tr>
<tr>
<td>197.75</td>
<td>16.29</td>
<td>8</td>
</tr>
<tr>
<td>197.6</td>
<td>14.25</td>
<td>7</td>
</tr>
<tr>
<td>196</td>
<td>12.21</td>
<td>6</td>
</tr>
<tr>
<td>195.8</td>
<td>10.180</td>
<td>5</td>
</tr>
<tr>
<td>194</td>
<td>8.144</td>
<td>4</td>
</tr>
<tr>
<td>193.21</td>
<td>6.108</td>
<td>3</td>
</tr>
<tr>
<td>188.28</td>
<td>4.072</td>
<td>2</td>
</tr>
<tr>
<td>185</td>
<td>2.036</td>
<td>1</td>
</tr>
<tr>
<td>182.87</td>
<td>1.982</td>
<td>.982</td>
</tr>
<tr>
<td>176.85</td>
<td>1.884</td>
<td>.884</td>
</tr>
<tr>
<td>176</td>
<td>1.786</td>
<td>.786</td>
</tr>
<tr>
<td>170.07</td>
<td>1.688</td>
<td>.688</td>
</tr>
<tr>
<td>167</td>
<td>1.587</td>
<td>.589</td>
</tr>
<tr>
<td>162.25</td>
<td>1.4912</td>
<td>.4912</td>
</tr>
<tr>
<td>158.0</td>
<td>1.3929</td>
<td>.3929</td>
</tr>
<tr>
<td>153.</td>
<td>1.2947</td>
<td>.2947</td>
</tr>
<tr>
<td>149</td>
<td>1.2315</td>
<td>.2315</td>
</tr>
<tr>
<td>141.5</td>
<td>1.1785</td>
<td>.1785</td>
</tr>
<tr>
<td>140</td>
<td>1.1166</td>
<td>.1166</td>
</tr>
<tr>
<td>131</td>
<td>1.0544</td>
<td>.0544</td>
</tr>
<tr>
<td>126.10</td>
<td>1.0023</td>
<td>.0023</td>
</tr>
<tr>
<td>122</td>
<td>9.205</td>
<td>.205</td>
</tr>
<tr>
<td>113</td>
<td>8.644</td>
<td>.644</td>
</tr>
<tr>
<td>104</td>
<td>8.181</td>
<td>.181</td>
</tr>
<tr>
<td>101.76</td>
<td>7.718</td>
<td>.718</td>
</tr>
<tr>
<td>101.17</td>
<td>7.255</td>
<td>.255</td>
</tr>
<tr>
<td>97.67</td>
<td>6.842</td>
<td>.842</td>
</tr>
<tr>
<td>95</td>
<td>6.430</td>
<td>.430</td>
</tr>
<tr>
<td>93.83</td>
<td>6.028</td>
<td>.028</td>
</tr>
<tr>
<td>89.54</td>
<td>5.626</td>
<td>.626</td>
</tr>
<tr>
<td>86</td>
<td>5.223</td>
<td>.223</td>
</tr>
<tr>
<td>84.64</td>
<td>4.821</td>
<td>.821</td>
</tr>
<tr>
<td>79.06</td>
<td>4.428</td>
<td>.428</td>
</tr>
<tr>
<td>77</td>
<td>4.035</td>
<td>.035</td>
</tr>
<tr>
<td>72.35</td>
<td>3.642</td>
<td>.642</td>
</tr>
<tr>
<td>68</td>
<td>3.250</td>
<td>.250</td>
</tr>
<tr>
<td>63.98</td>
<td>2.857</td>
<td>.857</td>
</tr>
<tr>
<td>59</td>
<td>2.464</td>
<td>.464</td>
</tr>
<tr>
<td>52.67</td>
<td>2.071</td>
<td>.071</td>
</tr>
<tr>
<td>50</td>
<td>1.678</td>
<td>.678</td>
</tr>
<tr>
<td>41</td>
<td>1.285</td>
<td>.285</td>
</tr>
<tr>
<td>34.55</td>
<td>.992</td>
<td>.992</td>
</tr>
<tr>
<td>32</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

In open kettles it is desirable to carry boiler pressures at from 80 to 100 pounds or even more and to get the steam into the jacket or coil at as nearly that pressure as practical. A wide difference in temperature between the steam side of the metal and the food side insures rapid circulation and evaporation. The same principle holds with the vacuum pan, but since boil-
ing takes place at a much lower temperature and the flavor of the milk is injured by prolonged exposure to heat, the temperature in the heating element is held as low as practicable or between 5 and 10 pounds (225° to 240° F.). If the steam be generated in high pressure boilers, reducing valves with proper thermo-regulators are necessary. This may require the injection of sufficient moisture to convert the dry steam into moist steam as the temperature of dry steam is considerably above that for a corresponding pressure of moist steam. At least in practice the injection of water has been found advantageous.

The vacuum is maintained at from 25.5 to 27 inches, some variation being made for the elevation of the plant and the amount of water available for condensing. The higher the vacuum, the lower the boiling point, the more rapid the evaporation, and the less change in the character of the milk but more water is required for condensing. With a lower vacuum, more heat is permissible in starting the batch and while the milk is perfectly fluid, later when it becomes heavier and viscous, it requires more regulation, a detail which can be learned only by experience.

The end point on a batch is determined by taking a sample or technically making a “strike.” Special devices are attached to the pan so that the sample may be taken without interfering with the evaporation. Since the batch was adjusted for fat content before the forewarming, the test at this point is upon the specific gravity, based upon a concentration of 2.2 to 1. A special lactometer or spindle is used in most plants or the determination is made with an Abbe refractometer. In one form of apparatus, a side tube with valves is arranged so that the hydrometer reading may be taken without removing the milk from the pan. The operator learns from experience the approximate point at which a batch of milk will be ready, and from 15 to 10 minutes before it is finished samples are taken at short intervals, and by timing the rate of evaporation he can judge the point with much accuracy.

Similar testing is done when using the continuous system so that the outflow may be regulated accordingly.

When the batch pan was used, it was customary prior to the introduction of the homogenizer to superheat the milk in order to affect the body. This might be done in the pan by shutting off the vacuum pump and turning steam into the coil or it might be directly into the milk, or the milk might be drawn into the receiving vat and the heating done there. The milk was heated to from 180° to 200° F. for a very few minutes, the whole operation of raising the temperature and holding it taking from 10 to 20 minutes, subject to the judgment of the operator. The heating at this point is more effective than in forewarming. With the introduction of the homogenizer this step has been abandoned and the evaporated milk, whether produced by the batch system or the continuous system, is pumped immediately to that apparatus as the operation is carried out more effectively upon warm than cold milk.

It may be added that in preheating with live steam there is dilution of the milk due to the condensation so that allowance must be made for this in determining the end point.

A finished batch in a six-foot pan varies from as low as 5,000 to as high as 6,000 pounds, depending upon the depth of the milk which the operator
prefers to use. The total milk used varies from 11,000 to 13,200 pounds, and the time required from starting to draw the milk to emptying the pan from 1.5 to 2 hours. In the continuous system, the evaporation in a six-foot pan can be pushed to about 18,000 pounds of milk per hour after the pan is once filled, and with no loss of time in discharging.

**Homogenizing**

The object in homogenizing is to break up the fat globules into such small forms that they lose their tendency to rise and float on the surface or to form small masses of butter in the can as a result of rough handling or shipping. The tendency for such fat separation is most marked in milk from breeds which produce large fat globules such as the Jersey and Guernsey, and is less marked in Holstein milk. Homogenizing reduces the size of the globules below that which occurs in nature.

The principle of the homogenizer is to force the milk through very minute openings under a pressure of from 2,000 to 3,000 pounds per square inch. The operation is naturally slow so is carried out on the evaporated portion to take advantage of the reduced volume while it is hot and before going over the cooler. The homogenizing also affects the viscosity to some extent. The capacity of the larger homogenizers is about 800 gallons per hour.

**Cooling and Standardizing**

Various types of cooling devices are used, the most important consideration being the ability to reduce the temperature quickly to about 40° F. and be able to clean them with ease. The cooled milk is held in vats for final standardization for fats and total solids to insure compliance with the minimum requirements of the Federal Food regulations and for correcting the acidity. This work is regarded as so important that it requires the services of a trained milk chemist, and is done so well that little milk is found below standard. The cooled milk is held in vats which rest upon scales so that exact weights may be obtained. The milk is slowly agitated in order to insure uniformity. The minimum requirements are that “all tolerances being allowed for, not less than seven and eight-tenths per cent (7.8%) of milk fat, nor less than twenty-five and five-tenths per cent (25.5%) of total milk solids; provided, however, that the sum of the percentage of milk fat and total milk solids be not less than thirty-three and seven-tenths per cent (33.7%).” This standard was worked out to conform to the composition of the most popular commercial evaporated milk at the time and was representative of the best factory practice. No modification has been made since though the methods of packing have been improved. The European standards are generally higher, but it is doubtful whether their milk would find equal favor in the American market.

The correction for fats is very simple as the deviation from that required will be only the slight amount due to not obtaining the exact ratio of concentration or the slight increase in the ratio purposely made so that dilution can be made to the point desired. The correction for total solids is a little more complicated, but special methods and apparatus for testing have been devised and formulae worked out which make the work comparatively simple. Heated cream, skim milk, or water is added as may be necessary to make the proper correction.
The final step is to test for acidity and the usual procedure is to neutralize a measured sample with a standard alkali solution, using phenolphthalein as an indicator. The acidity of the milk is of two kinds, natural acidity which is normal to the milk and acquired acidity due to microbial action. The former varies slightly with the season, with the feed, and with the animal, though the last factor may be regarded as negligible in herd milk. Acidity due to bacterial activity depends upon the volume of lactic bacterial infection, the length of time, and the temperature in holding the milk. This is the important factor in the variation in acidity and the part which requires neutralization when the total exceeds a certain amount. It is a debatable point whether the natural acidity ever runs so high as to require neutralization in order to make an acceptable product.

Neutralization is conducted under the euphonious designations of "stabilizing the casein" and "correcting the salt balance." The ingredients used are bicarbonate of soda, disodium phosphate, and sodium acetate.

The natural acidity of milk ranges from about .1 to .15 per cent, the average being close to .13 per cent calculated as lactic acid. The ranges for herd milk may go slightly beyond these figures at times and individual animals may show considerably wider variations. In the routine testing of milk, one cannot differentiate between natural and acquired acidity, therefore, any milk containing acidity in excess of .18 per cent is usually neutralized to that point or slightly below and due allowance made for the ratio of evaporation when the neutralization is conducted after the milk has passed through the pan.

In order to make the correction for acidity, about eight cans of milk are drawn off and different amounts of neutralizer used, varying by only small increments. Samples from these cans are then run through the test sterilizer and the sample which turns out most nearly perfect is used as a guide for the treatment of the entire batch.

From a theoretical standpoint, one can hardly fail to observe that the milk as it comes from the vacuum pan is in ideal condition to go into the can. It is free from all gases and at the proper temperature to give an almost ideal fill in the container and be ready for the sterilizer without any delay. It would seem logical to make all the adjustments for fats and solids, the correction for acidity, and homogenizing at the beginning so that the work might be continuous to prevent being carried over into the second day. That is at least a desirable end.

At this point any milk recovered from the pan, vats, or filling machine at the end of the operation should be filled into eight-gallon cans and placed in the retort and heated to 225° F. before being returned to the batch the succeeding day. This precaution is necessary to prevent the development of heat resistant types of bacteria which might infect whole batches.

Filling the Cans

The batch is stirred gently and filled into cans by machines employing gravity, force, or vacuum, depending upon the type of can used or the preference of the user. Gravity is always used to fill the open top cans. Most solder-sealed cans are filled by means of a small tube through the vent, and in one type of machine the cans are inverted during the filling.
In all cases the fill is determined by a measuring device so that accuracy in the amount is assured. Formerly the filling was done with the milk cold; that is, around 40° F., but more recently the practice is to pass the milk through a continuous heater and raise it to about 70° F. The filling, or rather closing, at such a low temperature is contrary to good practice in other lines of canning.

The solder sealed can, which is the one generally used, is closed by a drop of solder on the vent; the open top can is closed by double seaming in the usual manner. It has been recommended that the latter be sealed in vacuum but this is not followed. In both, the soldering in forming the can should be done with a non-acid flux. The preference for the solder sealed can is due to the slight difference in cost, which when extended to millions of containers becomes a considerable item.

Plain tin cans only are used and the great bulk of the milk is packed in one size, the No. 1 tall (4 3/4 inches in height by 3 inches in diameter), 48 to the case. A smaller or baby can (2 1/2 inches in height by 2 1/2 inches in diameter) is packed 96 to the case, and a few No. 10 cans for large users. In January, 1931, the No. 1 was superseded by two others, one 3 3/4 inches in height by 3 inches in diameter and the other 4 inches in height by 2 1/2 inches in diameter, each holding the same quantity of milk, 14 1/2 ounces, but condensed to such a degree that when 17 1/2 ounces of water are added, it will give a quart equal to that when 16 ounces of water were added. The result is a saving in cans, in casing, and freight.

Cooking

After the milk is once in the cans and sealed, there should be no unnecessary delay in getting it into the cooker. Formerly when all cooking was done in batches there was a certain amount of delay incident to accumulating a sufficient number of cans for a charge and also while waiting for a batch to be completed in order to accommodate another lot. This has been corrected in part by the use of high speed filling and closing machinery, but the ideal is reached in the continuous system where the cans go directly from the closing machine into the cooker.

In the batch system the cans are placed in frames holding two dozen each, and these are loaded into the reel mechanism. The cans rotate with the reel and have no independent motion. The rotation is generally end over end, and the amount of agitation is dependent upon the speed of the reel and whether operated continuously or intermittently. Agitation is a necessity in order to have a uniform rate of heating the contents of the cans, to prevent milk from sticking to the walls, to avoid a burned flavor, and the formation of skin in the headspace. The batch type of sterilizer has been improved at various times and is well adapted for small operations and where more than one size of can is used, but is lacking in the high degree of uniformity obtainable in the continuous system. The outer rows of cans act as a baffle in protecting the inner rows, thus resulting in some uneven heat treatment, a matter easily demonstrated by systematic examination of cans.

The heating is done by means of steam inlets at the bottom of the retort, usually three, four, or five equally spaced with respect to the feedpipe. Uniformity in heating is better assured when water is used to the depth of
the bottom crate as the motion of the reel prevents the formation of dead or cold spots.

The retort is closed, water turned in to the required height, and then the steam, the blow-off being left wide open until the temperature reaches 212° F., then reduced to such opening as will insure proper circulation. The temperature is brought to the desired point as 236°, 238°, or 240° F., depending upon the necessities in the particular plant and for the time necessary for sterilization. The time required to bring up the temperature is generally from 15 to 17 minutes, or longer than for most vegetables. The holding time is usually from 15 to 18 minutes at 240° F. and a few minutes longer if a lower temperature be used. During the coming-up period the reel is operated continuously, then intermittently during the holding period, and continuously while cooling. If no water be used in the retort, the coming-up time is increased about three minutes. The speed of the reel is generally from 1 1/2 to 2 revolutions per minute. The shorter the holding period can be made with safety, the better the appearance and the less the cooked flavor of the milk. The higher the temperature, the greater the viscosity. One method of manipulation for giving a heavier appearance to the body is to carry the temperature of the retort to about 245° to 246° at the start, hold it for a minute or a little more, then drop back to the degree of heat used for sterilization. Since the temperature used is governed by two factors, that necessary for sterilization and that desired to produce the body in the milk and the appearance desired, it is important to employ test batches at frequent intervals as a guide in keeping the milk on the safe side. The amount of agitation during the holding period is a factor in the appearance and the exact manipulation is guarded with secrecy by many superintendents.

Cooling

Cooling is essential for the production of a light color in milk and it was from the practice in this line that it became a part of the regular operation in nearly all lines. The blow-off is opened, the hot water drained, and cold water turned in preferably at the bottom. The reel is kept in continuous motion and at a higher speed than during sterilization, or at the rate of from 3 to 5 revolutions per minute. This is important in preventing a skin forming in the headspace in the can. The cooling is continued until the temperature drops to 100° F. or below.

The time required to load, sterilize, and empty a batch is about one hour and a quarter.

The cans are inspected for leaks as they are taken from the crates and then given a vigorous shaking in a power machine to secure uniform distribution of the fat in the milk. The cans are stored in the warehouse for thirty days to await development of possible swells or other defects before shipping in the trade.

The batch system is the more practical for small operations, where a variety of sizes are used, or where it is desired to vary the processes.

Continuous Sterilization

The sterilization of the milk by the continuous process is the latest development in the industry and is the most important step since the invention of the agitating pressure cooker in 1885. It represents the highest
form of mechanical equipment used for sterilization, and it is doubtful whether there is any operation in the entire industry carried out under better control.

The continuous process is an adaptation of the methods developed for the sterilization of some vegetables, and was first tried in the summer of 1921. Sterilization of the milk was readily accomplished but the product did not correspond in all respects to that which the consumer had been taught to believe was the best. The milk treated by the batch system had a certain body or viscosity which was lacking in the new product. As a result a preheater had to be designed which would automatically bring the temperature up by degrees, subjecting the cans to successive baths at gradually increasing temperature, hold them for a given time before carrying them into the retort and thus produce the desired effect. The work had to be done more rapidly and with greater certainty than by the batch method. It was also necessary to hold the milk within a narrow range for varying periods and under different conditions of agitation, all of which had to be worked out experimentally to fit the new conditions. It was during this period of experimentation that much was learned relative to the factors affecting the viscosity of milk and the factors controlling it.

The preheater consists of a cylindrical tank with a reel and spiral similar to the cooker but baffle plates so spaced on its interior as to prevent the free circulation of water, with steam openings in the bottom of the tank likewise spaced and of such size that any desired temperature can be maintained in the different parts. For example, the entrance may be at 90° to 100°, the second compartment at 130°, the third at 150°, the fourth at 180°, and the fifth at 205° F., these having been found to be the desirable steps in practice. The holding is done at 206° in a second heater and the time governed by the point of discharge. The agitation, whether continuous or interrupted in the preheater, and also in the sterilizer, is determined by the use of non-agitating supports in the reel. The time taken for raising the temperature is ordinarily from 10 to 12 minutes, for the holding about 12 minutes, though this may be varied from 3 to 15 minutes as may be required, and the time in the sterilizer 15 minutes, and for cooling 10 minutes. The cooling unit is similar to the sterilizer and connected with the latter by a closed passage so that pressure may be maintained on the outside of the can. The can enters at the point where the water is hottest and emerges where it is coolest so that it follows the reverse course from that of the preheater.

While this development was in progress another was perfected which takes out all leaky or defective cans after passing through the preheater and before entering the sterilizer, and again after coming through the cooler. This double check is by a method far more sensitive than any workman.

The can tester or leak detector is very simple in construction but invariable in operation. It consists of a pair of slightly convex disks mounted on a shaft and spaced slightly more than the height of a can so that those which remain unchanged will pass between the disks on the runway, and those which have distended ends will be lifted between the disks onto another runway. The perfect cans continue in their normal course, the imperfect are diverted for repair. In the preheater all sound cans have the ends dis-
tended owing to the expansion of the milk and air within, while those which are leakers allow the air and milk to escape so that the ends remain flat. These latter cans are dropped between the disks. When the cans come out of the cooler, all those which are tight have the ends drawn in by the contraction of the milk, while those which have leaks are distended. Milk is forced through a leak while the can is in the sterilizer and the ends thus being distended do not return while in the cooler and are thus separated by the last pair of detectors.

While the percentage of leaky cans is normally small, much labor is required to separate them by manual examination. The detector does it quickly and at the points where little loss results from spoilage of the contents. The cans thrown out on the first test may nearly always be retipped or patched, and those which cannot be so treated in the second test may have the contents emptied and used in a subsequent batch. The recovery of cans and milk during a year amounts to a considerable sum, besides the work is so nearly perfect that the product can be labeled and shipped without storing in a warehouse.

A further check is the installation of a weighing machine in the line to separate short weight cans.

In this continuous system the cans do not require shaking before boxing. The machinery has been practically standardized to handle 105 to 130 cans per minute, or 160 cases per hour.

In this system the can becomes the unit of treatment and advantage is taken of its shape, rolling on its long axis so as to get the optimum of heat penetration in sterilizing and radiation on cooling.

The patent covering the process is given as an appendix.

Cleaning

An evaporating equipment must be kept scrupulously clean. Milk is an ideal medium for the growing of a very great many of the ordinary organisms which cause decomposition and other objectionable changes as well as some which may cause disease. There is enough albuminous matter in milk so that if it strikes a warm or hot surface, it quickly forms a film and adheres tenaciously. This film tends to protect the more heat resistant organisms and spores and thus may add infection to the milk which follows. The film can be removed only by thorough washing, usually by scrubbing and the use of alkalies or detergents followed by vigorous rinsing.

The receiving tank, hot wells, and holding tanks have plain surfaces which are easily accessible so it is a comparatively easy job to clean them but as much cannot be said for the vacuum pan and some other parts of the equipment.

The cleaning of the vacuum pan is the most unpleasant task. The manhole is generally small so that a small person is assigned to the job of going inside. The metal retains some of the heat after being in use which in connection with the humidity and confined space virtually provides Turkish bath conditions. The arrangement of the coils is so restricted that it is difficult to get at all parts even with the special brushes provided for the purpose. The designers work primarily on the idea of getting the largest amount of heating surface in the space occupied, which is good from the engineering standpoint but may not be from that of good care. No short-cut
methods have been found for good cleaning but dependence must be placed upon hand washing and scrubbing with final rinsing, preferably with hot water. The dome and condenser must be given the same treatment and an outside type of condenser should be provided with extra handholes as the regulation openings are inadequate. In emergencies the pan may be hosed down, the coils covered with water and allowed to stand, then drained and given a thorough steaming followed by rinsing. In the batch method it is best to rinse thoroughly between each usage.

Flash heaters are filled and soaked with water then given a thorough brushing and rinsing. Some soak first with hypochlorite solution, then with alkali and rinse with water under heavy pressure. The homogenizer is operated first with hot water, then with hypochlorite, followed by the alkali and scalding water. At intervals the machine is opened and given a hand washing. The filling machine is treated in like manner but dismantled every five days. Pieces of piping, valves, fittings, etc., are washed and then sterilized in the retort. Upon starting operation, all the apparatus is rinsed, preferably with hot water.

A steam hose with a special nozzle to get steam into every point where germs might find lodgment is a valuable accessory in obtaining efficiency and lessening hand work.

Metals

While milk does not have the strong chemical affinity for metals displayed by many foods, it is so sensitive that slight action is reflected in color and to the sense of taste. Iron is the most grievous offender of the metals used in evaporating plants and should be eliminated in all parts coming in contact with the milk, or where used to give the required strength, it should be well tinned.

Copper has been and still is the standard material for the vacuum pan, jacketed kettles, and heating coils, and tinned for hot wells, pasteurizers, coolers, receiving bowls for the filler, piping for milk, etc. In all cases the tinning is removed to a greater or lesser degree after a time. Milk remaining in contact with copper becomes slightly brownish or brownish red and acquires a distinct metallic taste. At one time the slight darkening was looked upon as an advantage in giving the appearance of richness in cream. Now that the cause has been determined, it is considered a fault in manufacture except by the few who find copper to be advantageous in the diet. Milk prepared in a continuous evaporating pan suffers less change than that prepared in batches.

The use of the new steel alloys as stainless steel, chrome steel, chrome nickel steel, and others of similar composition are practically free from attack by milk and the result is finer, a whiter, cleaner color, and no foreign flavor. These metals are also being used in the accessories, as the receiving tanks, hot wells, flash heaters, coolers, etc. They are expensive but are certain to supplant copper in time. They are light in weight, strong, and good conductors of heat so possessed of all the good qualities of copper. Aluminum has the drawback in that it is corroded by alkalies used in cleaning. Glass-lined tanks are excellent for some purposes but are heavy, heat conduction is slow, so are best suited for storage tanks.

The progress made in the study of metals in the past five years is of importance from the standpoint of appearance and flavor.
Patent No. 1,721,751, July 23, 1929, issued to A. R. Thompson, San Jose, California, covers the continuous system of sterilization as follows:

I have discovered that the quality of canned milk and its keeping properties are greatly improved by the following method of treatment. The milk should be gradually heated in the containers up to about 200° F. to 210° F., and then held at a temperature of about 210° F. for an appreciable time, according to the milk being treated.

Milk varies greatly from season to season, and also from day to day, and also in different localities, and the length of time at which the milk should be held at the uniform temperature of about 210° F. must be varied to suit the varying conditions of the milk itself. The deposition of a coating of albumin on the interior surfaces of the containers is prevented by subjecting the containers filled with the milk to a gradually increasing temperature, beginning at about, say, 110° F. and increasing gradually to 200° F. and subsequent separation of the milk in the containers is prevented by holding the containers for a few minutes at a uniform temperature of about 210° F., as above stated, the time varying according to the nature of the milk being treated. Thereafter, the milk can be sterilized by subjecting the containers to a temperature of 240° F. for the required time.

Heretofore a great deal of difficulty has been experienced in producing the desired viscosity in canned milk with a constant time factor; and while more or less viscosity may be obtained by varying the temperatures of the heat zones in the preheater, and varying the temperature to a certain extent in the sterilizer, the results are uncertain. I have discovered that by holding the cans under a constant temperature, or practically so, in the preheat holder prior to sterilizing, I obtain very gratifying and practically uniform results.

My invention consists in brief in a novel method of processing canned foods, and particularly canned milk comprising passing the cans in a continuous stream through a series of preheating regions of successively increasing temperature, beginning, say, at or below 110° and gradually increasing up to 200°; then passing the cans into a preheat holding chamber where they are kept at a temperature of about 210° for a length of time, depending upon the nature of the milk, as above stated. The length of time that the cans are held in this holding chamber can be varied, as desired; preferably by varying the length of travel of the cans through said chamber without stopping or varying the speed of travel of the cans; either by varying the point of feed of the cans into the "holding" chamber, or varying the point of discharge of the cans therefrom. This holding chamber should be maintained at a uniform maximum temperature of approximately 210° F., below the temperature required for sterilizing. The cans are then passed from the holding chamber through a suitable sterilizer wherein the temperature is maintained at that required for sterilizing, usually at 240° F. The cans are finally passed from the sterilizer, without exposure to the atmosphere, into and through a cooler in which a temperature of about or below 150° is maintained; and the cans are retained in such cooler until their contents are sufficiently cooled to eliminate any danger of rupture of the can by internal pressure when they are discharged into the atmosphere. The cans in passing from the preheated to the "holding" chamber, and from the latter to the sterilizer, are preferably passed through suitable "leaky" can detectors, so that any defective cans may be detected and removed.

In each case the cans are gradually heated in the preheater to approximately 200°, are then discharged into the preheat-holder, where they are maintained at a uniform heat of approximately 210° F. for from three to twelve minutes, as the particular milk being treated may require. By gradually heating the cans and then holding them for a short time under a uniform temperature of about 210° F., the albumin in the milk is caused to begin to coagulate before the cans enter the sterilizer; and then, as the cans pass through the sterilizer, wherein they are subjected to a temperature of about 240°, the milk is brought to viscous condition which prevents so-called "separation," that is the lighter components of the milk such as butter-fat and cream will not rise to the surface when the cans are cooled and stored.
CHEESE

Though cheese is a very old dairy product, much older than butter in its common usage, and made in probably greater variety than any other food, the means for keeping it have made no radical change until within the past twenty years. Cheese is inherently an unstable product, requiring the action of certain organisms to cause the changes in the curd that are recognized as desirable, after which deterioration takes place more or less rapidly depending upon the conditions under which the cheese is kept and the invasion by adventitious organisms. To preserve cheese when it has attained its best condition and in a form suitable for delivery at any time or place is manifestly an important contribution to the art of conservation and for which the industry is indebted to J. L. Kraft, of Chicago. Its accomplishment represents a vast amount of experimental work covering a period of several years. His product was first placed upon the market in 1914, and in 1918 the government purchased 6,000,000 pounds for its various needs, principally for the army, navy, and hospitals—enough to make the product known over the entire country.

The distinctive feature in the canning of cheese is that sufficient heat be applied to cause the destruction of the organisms present without causing disintegration or separation of the constituents. Cheese is a poor conductor of heat and easily broken down at a temperature considerably below boiling, whereas some of the organisms present are not destroyed at the usual temperature of pasteurization, or 145° for 30 minutes. The problem therefore became one of getting the cheese into a condition for uniform heat treatment and determining the working limits, above which there is danger of injuring the product by the heat and below which sterilization was not effected. There was no precedent to serve as a guide, though somewhat analogous problems occur in canning of some other products. The method in this case was developed by making trials to determine the temperature limits.

Kraft Patents

The process is covered by patent No. 1,186,524, issued June 6, 1916, to J. L. Kraft, Chicago, Illinois. The description in the text of the patent is as follows:

This invention relates to an improved process of sterilizing cheese to render it permanently keeping, and to the product thereby produced.

The chief object of the invention is to convert cheese of the Cheddar genus into such condition that it may be kept indefinitely without spoiling, under conditions which would ordinarily cause it to spoil, and to accomplish this result without substantially impairing the taste of the cheese. Incidentally, the process has a marked value in that it has the effect of permanently arresting the curing or flavor-development of the cheese, from which it follows that the cheese may be brought to the precise stage of ripening desired and then permanently arrested and kept in that stage or condition until consumed.

The invention consists in the matter hereinafter described and more particularly pointed out in the appended claims.

It is common knowledge that various food products may be sterilized by the application of heat and then hermetically sealed under sterilized conditions and so rendered permanently keeping. But the attempt to apply such treatment to cheese of the Cheddar genus has invariably resulted in failure, so far as rendering the product permanently keeping is concerned.
It is a well-known fact that cheese of the Cheddar genus cannot be heated to a temperature much above its melting point without disintegrating and permanently losing its true cheesy character. That is to say, the melted cheese becomes stringy and the casein and fats separate and cannot be returned to their original combined true cheese form and homogeneous condition. For this reason it has been impossible to treat such cheese to a high sterilizing temperature without spoiling it, and completely sterilized and permanently keeping cheese of the Cheddar genus has not been produced prior to my discovery.

I understand that various cheeses, especially of the soft varieties, such as Camembert, Limburger, Brie, etc., which in the advanced stages of curing become liquid or semi-liquid, have been made permanently keeping by sterilizing with heat and sealing hermetically under sterilized conditions. I believe the explanation to be that in the process of making and curing soft cheese of the varieties stated, all of these bacteria which can only be killed by heat of a comparatively high degree, have been killed off (possibly by a toxic condition of the cheese as regards such bacteria, developed by the curing), while the remaining bacteria are all such as may be killed at a relatively low temperature—a temperature that at which the cheese will disintegrate and be spoiled. Hence sterilization of these cheeses has been possible. On the other hand, in the case of cheese of the Cheddar genus, the making and curing or ripening does not eliminate bacteria present and which require a relatively high temperature to kill them, and it follows that the high temperature for sterilizing is imperative, and coupled with such high temperature from spoiling or disintegrating the cheese.

I have discovered that cheese of the Cheddar genus may be prevented from disintegrating under the action of heat of as high temperature as 175° F., or even more, by subjecting the mass to proper agitation and stirring continuously or substantially continuously throughout the period beginning with the application of heat to the cheese, and continued until it has reached the necessary temperature amply long enough to insure thorough sterilization. A temperature of 175° F. maintained for a period of ten or fifteen minutes is ample to insure thorough sterilization.

In carrying out my improved process, a preferred way is substantially as follows: The cheese having been made and cured to the desired stage in the usual or any suitable way, the bandages are removed and the cheese cut up into small pieces, preferably by the use of a suitable slicing machine; the cutting up being desirable to facilitate the stirring in the early stages and to allow the heat to penetrate quickly and with approximate uniformity. The cut up cheese is placed in a steam jacketed or hot water jacketed kettle, or other suitable heating device wherein it may be subjected to the desired temperature without scorching. The kettle or other receptacle in which the cheese is treated is desirably equipped with mechanical stirrers, though stirring might be performed manually. The steam, hot water, or other source of heat, is then applied gradually to the vessel and the temperature raised until the contents of the kettle reach approximately 175° F. at approximately which temperature it is held for a period sufficient to completely destroy the life of all bacteria, usually for approximately fifteen minutes. While the cheese is being melted and while it is held at sterilizing temperature, it is actively stirred or agitated by suitable stirrers, and this treatment results in maintaining the mixture homogeneous and from losing its true cheese character. After complete sterilization is assured, the liquid cheese is run off into suitable containers and, ordinarily, hermetically sealed under sterile conditions. After it has cooled, it possesses its original flavor unimpaired, or substantially unimpaired, and its texture is homogeneous and substantially the same as it was before the treatment, excepting of course, the elimination of such cellular cavities as may have existed in the cheese. The hermetically sealing under sterilized conditions is preferably accomplished by drawing off the cheese into thoroughly clean cans or jars and sealing these while the cheese still remains at a sterilizing temperature. The subsequent cooling of the contents of the containers produces a partial vacuum and causes atmospheric pressure to supplement the mechanical pressure through which the seal is effected; such vacuum sealing being well understood in the art of canning and packaging fluids.

In a descriptive article upon the same subject (Canning Age, July, 1922, p. 15), the melting of the cheese is given as 160° F. and requiring from 50 to 60 minutes under continuous agitation. Cheddar cheese is used principally. Pimiento, chili, and other condiments may be added to obtain certain variations. The packing is done in 4 and 8 ounce, 1-, 5-, and 7-pound containers.
Patent No. 1,350,870, August 24, 1920, also issued to Mr. Kraft, supplements the foregoing as follows:

Describing the preferred way of carrying out the process, I select cheese of the desired kind, condition and degree of ripeness and, after removing the bandages, comminute the cheese, usually by the use of an ordinary cheese slicing or grinding machine. I next place the cheese in a steam or water jacketed kettle or other suitable heating vessel, wherein it may be subjected to the required temperature without scorching. The kettle or other heating vessel is preferably equipped with mechanical stirrers, by which the cheese may be stirred actively while undergoing treatment, but the stirring may be done manually with a paddle, spoon or other suitable implement.

The steam, hot-water, or other kind of heat is applied to the vessel and the temperature of the contents thereof gradually raised until the cheese is thoroughly melted. While the cheese is being melted it is actively stirred and this stirring is continued until the cheese reaches the proper condition sought by this step. The temperature of the cheese is raised to about 120° to 140° Fahrenheit, after reaching which temperature the heat is so regulated as to prevent it from rising much higher; but the temperature is maintained for a period and until the cheese reaches a condition which I term a stably-homogenized condition. The heat-and-stirring treatment is then stopped. This stably-homogenized condition has been reached, and is shown, when the cheese appears smooth and homogeneous throughout, and has a marked viscous consistency, so that it can be drawn out, while hot, into long attenuated strings like taffy or very thick syrup. Ordinarily, the homogeneous treatment will require from 30 to 50 minutes to raise the temperature of the cheese to the desired point, and a further treatment of from 10 to 15 minutes to bring it to a fully stably-homogenized condition.

At the conclusion of the homogenizing step, the cheese is in condition to withstand an indefinitely continued temperature of 212° F., or more, without disintegration or separating out of its butter fat, although it be subjected to such heat without stirring or agitation.

The cheese is next placed in cans, jars, or other containers, capable of being hermetically sealed, and after being sealed is processed to effect sterilization.

To secure effective sterilization so as to insure permanent keeping qualities in the cheese under all climatic conditions, it must be brought to a temperature of about 175° F. and kept at or above that temperature for about fifteen minutes, although a somewhat lower temperature, say 160° F., continued for a longer time, say twenty or thirty minutes, is usually sufficient to effectively sterilize.

Accordingly, after the cheese has been put in containers and sealed, I put it in a steam chamber, or hot water, and subject it to the above described sterilizing heat for the requisite period. I do not find it necessary, or even desirable, to leave the cans unsealed, while being processed, as is sometimes done, but, of course, this way of proceeding is feasible, in which case each can or container must be sealed while the contents are in sterile condition.

Treating the cheese at a low temperature only while exposed to atmospheric and undergoing stirring or agitation, and subjecting the cheese to the required higher sterilizing temperature under sealed condition, minimizes the changes in flavor of the cheese due to heating it. That is to say, my present process, I believe, preserves the delicate flavors of the cheese somewhat better than does the process of my Patent No. 1,186,524. Because the open heating is at a lower temperature and for a shorter period, any possible change of flavor due to heat is minimized, and less moisture and less of the aroma of the cheese are expelled and lost. Inasmuch as skilled or expert supervision is required only during the period of the homogenizing step, a saving is effected in that respect. The possibility of infection while the cheese is being canned or packaged is avoided, since the sterilization is effected after the canning is completed.

No. 1,368,624, February 15, 1921, issued to G. H. Garstin, Sidney, New York, is for a method of insuring a homogeneous character in canned cheese. The important part of the patent is as follows:

In carrying out the steps of the process just mentioned, however, there arises a difficulty in maintaining the cheese homogeneous. As soon as the cheese is heated to a temperature much above its melting point and high enough to enable it to be poured into cans, the cheese begins to disintegrate. That is to say, the heat causes the butter fats to separate from the casein and to float upon the surface thereof. Except under special conditions it is not an easy matter to prevent this disintegration of the cheese, or to cause the butter fats and casein, after their disintegration, to reunite into a homog-
generic mass of the requisite smoothness. For this purpose it has in some instances been advisable to add to the cheese some material for use as a mulsifier.

I find that tertiary sodium phosphate (Na₃PO₄), designated in the United States Pharmacopoeia as medicinal sodium phosphate and which is the neutral salt of orthophosphoric acid, is an ideal substance for the purpose of maintaining the homogeneity of the cheese and of accomplishing the other results above contemplated. It is used to the best advantage upon cheeses which have no material acid qualities. English dairy cheese and other cheeses of the Cheddar genus, if not unduly aged, and various other kinds of cheeses if not rendered acid either by fermentation or by the use of a sour curd, may be treated in connection with the tertiary sodium phosphate.

I also find that if a cheese, for instance an English dairy or other cheese of the Cheddar genus, is very old and over-ripe and thus has become slightly alkaline owing to the presence of ammonia, it is practicable to use the acid sodium phosphate (NaH₂PO₄), or in other words the primary sodium phosphate to accomplish the result.

I proceed as follows:

To each 100 pounds of cheese, ground up or otherwise comminuted, I add 5 pounds of the sodium phosphate and 5 to 10 pounds of water, the sodium phosphate being in the form of a dry powder which dissolves in the water and therewith becomes incorporated in the cheese. The cheese mass is now placed in a steam-jacketed kettle and stirred by mechanical stirrers until formed into a smooth, semi-liquid mass having the consistency of very thick, condensed milk and entirely free from all lumps. The mass should be heated and stirred as described until it reaches a temperature of about 180 degrees Fahrenheit, the time being preferably from thirty to forty-five minutes. However, the length of time required to bring the mass to the required degree of smoothness is a matter of experience and judgment on the part of the operator, and of course varies with the kind and condition of the cheese. The object is to obtain a smooth, semi-liquid mass of the consistency of condensed milk and which will readily flow into tin cans, and for this purpose and temperature and the length of time required for the purpose may be varied as required.

The cheese mass is next caused to flow into tin cans which are paper lined, and the cans are closed and sealed in the conventional manner, usually upon an automatic sealing machine. The seal should be hermetrical.

Next the cans, now filled and sealed, are placed in a sterilizer and subjected to a temperature of 230 degrees Fahrenheit for a period of time, varying from forty minutes for cans of small size to an hour and a half for cans of large size—say, five pounds capacity. However, a somewhat lower degree of heat coupled with a longer time or a shorter time, can accomplish approximately the same result.

No. 1,389,095, August 30, 1921, issued to L. E. Carpenter, East Orange, New Jersey, and E. E. Eldridge, Sidney, New York, is for a method of sterilizing Swiss cheese and a part of the patent applies to preservation in cans.

For Swiss cheese, we proceed as follows:

We first grind the cheese, for instance in a sausage grinder, and add two or three per cent, by weight, of sodium citrate and eight to ten per cent, by weight, of water. We also add two per cent, by weight, of No. 1 Neufchâtel cheese. The mass is now heated to approximately 165° Fahrenheit, and stirred violently, while this temperature is maintained for thirty minutes. Dry salt is now added, sufficient in quantity to render the flavor saline to any extent desired. The mass is found to be soft and plastic, and all of the water it contains is diffused uniformly as moisture. The last step is to pour into molds or boxes.

Citrates having alkaline bases other than sodium may be substituted for the sodium citrate and in some instances the alkaline salt may be dispensed with altogether. The stirring, however, is quite essential in order to promote circulation and thus insure that every particle of the cheese is subjected to an adequate degree of heat. The stirring also tends to prevent the heat from burning the cheese or causing its disintegration.

In this connection we call attention to a fact which may be readily confirmed by casual observation, namely, that when cheese of any kind is heated under ordinary conditions, it is broken up and changed greatly in character. For instance, in making Welsh rarebit, where the cheese is simply heated in a frying pan to a temperature approximating the boiling point for water, the resulting mass is resolved into a viscous, adhesive yellowish material accompanied by a quantity of free butter fat. Again, if a
piece of cheese is heated to almost any temperature a little below the boiling point of water, the cheese will become grainy and lose a part of its flavor.

We have made the discovery that if the temperature used for heating be carefully adjusted as above described, a cheese may be sterilized or pasteurized, yet without being broken up or having any of its ingredients separated from others. The particular temperature for this purpose varies slightly under different conditions and with different cheeses, but allowing for this fact there is usually a proximate critical temperature at which the greatly desired result is easily accomplished.

In instances where two kinds of cheese are mixed, a single common temperature suffices for the mixture. Generally the mixture desired contains a soft cheese and a relatively small proportion of a harder cheese.

The steps such as grinding, adding water and salt and pouring into molds or boxes, though usually desirable in practice, are not in every instance absolutely necessary. The stirring, however, is essential.

No. 1,389,577, September 6, 1921, elaborates on the foregoing.

No. 1,462,375, July 17, 1923, issued to G. Meyer, Verndale, Minnesota, contains the following:

In accordance with the present invention, the already prepared cheese or base is comminuted, being preferably ground by machinery and to each two pounds of grated cheese is added one-half pound of natural milk. The milk and cheese are thoroughly mixed and are gradually heated to a temperature of 125° Fahrenheit. The mixture is maintained at this temperature for a period of ten to fifteen minutes and is constantly stirred. After the mixture has been thus treated a change commences to take place and the product assumes a stringy, dough-like or elastic appearance and when this stage is reached, the excess of milk is drawn off and the cheese is worked by being pulled in a manner similar to taffy candy until it reaches the desired consistency. The prepared cheese is now placed in cans and sealed air-tight and sterilized at a temperature of 190° Fahrenheit.

Cheese prepared according to this process does not change in texture or flavor and will not spoil or grow strong. It is to be understood that any flavor, such as pimiento, may be added according to the nature of the cheese to be prepared.

It should be stated that cream or butter may be substituted for the milk so that under certain conditions milk, cream or butter may be used according to the nature of the product to be produced.
THE CANNING OF MEAT

While the canning of meat is as old as the art itself, less is generally known about the commercial methods than in probably any other line in the industry. It seems to have been assumed from the beginning that any imperfection in the method resulting in spoilage might be attended with serious consequences so the canning should not be done by the inexperienced. It became a specialty with attendant secrecy. Strangely enough this same feeling did not apply to the canning of fish.

Appert made many preparations of meats from clear consomme to large roasts, being limited at first to such pieces as could be packed in bottles. Later he successfully packed single cans holding 37 pounds of beef prepared from 66 pounds of the fresh, and his successor, Raymond Chevallier Appert triumphed by packing the flesh of an entire sheep in one can. These were real feats in canning that would be difficult to duplicate at this time with all of our improved apparatus. The preparatory steps were the same as if the meat were intended for the table, the cooking being about two-thirds done, the bones and other undesirable parts removed, and the flesh covered with gravy or other special seasoning or dressing. The final cooking in the container was done in the water-bath.

There was practically no canning of meat done in this country prior to the Civil War as fresh meat was abundant everywhere except around a few of the larger cities while salt curing was carried on at every butcher shop so that people were accustomed to it. The total value of all slaughtered products was only $12,000,000 in 1850 due to the fact that such a large proportion of the animals were killed and consumed on the farm or in the home. That figure was increased to $785,000,000 in 1900, slaughtering in the meantime having become a much more specialized industry. The first commercial canning of meat was started in Chicago in the late sixties (1868), after the war, but not developed as an important item until about 1879. Libby McNeill and Libby pioneered in this field but were quickly followed by others operating at that time.

Meat canning has seldom been a primary objective in packing due to the fact that fresh and prepared meats are everywhere available by reason of cold storage and refrigeration facilities and the public has not become accustomed to looking upon the increased cost of canned meats as due to the elimination of waste and the removal of about one-third of the moisture. The canning of meats reached its maximum in 1919, the year following the war, much of it being for the troops and the allies. The total amount packed under government inspection was 632,259,000 pounds which dropped back to 86,240,000 pounds in 1931, and which was gradually and steadily increased to 361,502,000 in 1934.

The best early description of the canning of meats in this country is by Archdeacon* in 1876 and is typical of the most advanced practice of the period and for the quarter century which follows. It is very brief:

"CANNED FRESH BEEF"

"Take good fresh beef, and boil it in a tightly covered kettle, to prevent the escape of the aroma; boil it until it is tender, and the bones will easily

*Archdeacon, William. Archdeacon's Kitchen Cabinet, Chicago, 1876.
slip out. Add water from time to time during the boiling to supply the loss by evaporation. Remove the meat, and boil down the liquor to a rich gravy. Isinglass or other glutinous substances are sometimes added to the liquor to give it greater consistence; then remove the bones from the meat, and cut it sufficiently fine. Pack it in the cans with the fingers, tightly, and pour over it evenly all the gravy the meat will absorb, and by closely packing, and filling all the interstices, displace all the air from each layer until the can is full, except for space to cap. Weigh and cap carefully, leaving the vent open, then boil in an open water bath for half an hour; remove to the table and wipe the top of the can with a cold, wet cloth, to check the steam, and then quickly solder up the vent. If water be used for the second bath, the boiling must be continued about six hours, but if a chemical bath be preferred, 3 hours' boiling will be sufficient, but at an increased temperature, to about 240°.

"Fresh Mutton, Veal, Pork, Venison, and Other Meats"

"Pack same as fresh beef.

"Canned Roast Beef"

"Roast the beef as if for the table; make a rich, heavy gravy, adding to the gravy, flour or other glutinous matter to thicken heavy; flavor to suit the taste. Cut the beef in thick slices and pack solid in cans with the fingers while yet warm, filling up with hot gravy, until the can is full of meat and floated with the gravy. Bones should not be put in cans.

"Canned Roast Mutton, Veal, Pork, Venison, Bear and Other Meats"

"Same as roast beef.

"Corned Beef"

"Select good corned beef, freshen as is generally done for the table. The formula and pressing same as fresh beef, only cut up small, press in hard, as it will shrink. A thick glutinous gravy is necessary.

"Canned Sausage"

"Fill the cans well with fresh sausage, put in an open bath. It takes longer to heat through than any other meat, it being so solid. When perfectly hot, which must be assured, close the vent and process same as fresh beef.

"Canned Irish Stew"

"Make the stew same as for the table, half potatoes and half beef, well seasoned and boiled, not boiling quite done; fill up solid in cans and process same as for fresh beef.

"Canned Tripe (2-lb. cans)"

"The tripe must be fresh, not in vinegar; pack closely in cans and fill up with boiling water, slightly salted. Process same as fresh beef.

"(Note.—There is another mode of canning fresh meats, it is somewhat cheaper, and in some cases is practiced. It is to cut the meat up in its raw state, in pieces about 1 inch square; pack solid in cans; fill up with hot water with a little salt, and process same as fresh beef. This will do for any kind of meats, but the cans cannot be so full. It is claimed, however, that the flavor is better.)"
Patents

As patents frequently reflect the most advanced state of knowledge in an art at a particular time, it is pertinent to quote from the earliest granted for the canning of meats.

The first patent was granted to John A. Wilson, Chicago, Illinois, September 21, 1875, under Number 168,073.

Meat so prepared will keep sound and sweet, and will come out of the can in a solid state fit to be sliced and eaten, with only sufficient moisture to render it tender and palatable.

In working this invention, I first cook and properly season the meat, and then pack it, reasonably dry and close, into flat sided tin cans—using flat tins, or square pyramidal tins, because the flat sides will not offer any material resistance to the collapsing pressure of the air, but will yield and transmit the pressure to the meat. When duly filled, the can is hermetically sealed and by soldering it up, and then heating quite hot. Then a small hole is punctured through the tin and the expanded gases allowed to blow suddenly out, and the vent immediately soldered up. The ordinary atmospheric pressure thus brought to bear upon the exterior of the can collapses the flat sides, and accomplishes, without further aid, the desired solidification of the meat.

I prefer not to use cylindrical cans, because the cylindrical surface offers too great a resistance to the collapse, while the head of the can is stiffened too much by the opening loaded with solder, and commonly stamped with grooves. I prefer to use common tin, and have it perfectly plain and flat at all sides, so that it will readily yield.

I am well aware that various articles of food have been hermetically sealed in tins by first sealing the can containing the article, and then heating and puncturing and rescaling; and I am also aware that sardines and other fish have been preserved in square flat-sided tins hermetically sealed. My invention differs from all such in the fact that I pack the meat into the can until the can is full of meat, and employ no gravy, water, oil, or other liquid in conjunction with the article to be preserved, so that the pressure of the air upon the vessel will solidify the contents, and the meat will come out of the can in a fit condition to be sliced up for eating, and will be much less likely to spoil in keeping.

Patent No. 175,757, April 4, 1876, issued to A. B. Richardson, Dover, Delaware, recites:

My invention relates to an improved method of preparing hams for the market; and it consists in first withdrawing the bone from the ham, and then packing the ham into a specially-constructed can, after which it is hermetically sealed, and then cooked until it is sufficiently done to be ready for the table. The ham is thus cooked with all its natural juices and flavors preserved, and in consequence of the packing and cooking, the space left, after the bone is withdrawn, is perfectly closed, making the ham solid and homogeneous all through, so that the whole ham may be sliced through and through, and with the exception of a slight seam, bears no evidence of the former existence of a bone.

Patent No. 188,774, March 27, 1877, issued to Moses Brenner, Baltimore, Maryland, is for a mildly corned meat, cooking it, trimming it, and packing it in large pieces in flat sided cans instead of being cut as customary at that time.

Patent No. 217,226, July 8, 1879, issued to J. W. Jones, Portland, Maine, describes his process as follows:

I take raw beef or other meat, fowl, or fish, and pack the same closely into cans and hermetically seal the cans. Now the sealed cans are placed in hot water—say, two and a half hours—until the contents are completely cooked in the air-tight can. Then the cans are punctured while hot and the excess of water or juice of the meat not coagulated by heat is completely expelled by compressing the can in a suitable press, and then the puncture immediately sealed. Thus the beef or contents of the can are consolidated, and thecooling of the can further contracts the same and completes the compression and consolidation.
My process is as follows: I first put the meat into a mild pickle, permitting it to stand therein long enough to become sufficiently seasoned—say from twenty-four to forty-eight hours, according to circumstances; then I remove the meat from the pickle and put it into scalding water, allowing it to stand therein long enough to become heated through—say from five to ten minutes—the effect of which scalding is to bring the meat into such condition that all, or nearly all, of the absorbed water and a large percentage of the water originally in the meat can be removed by pressure. I then remove the meat from the scalding-bath and submit it to suitable pressure, and thereby remove the absorbed water and a large per cent of the water originally in the meat. I then place the meat in the cans and cook it, and seal the cans in the usual manner.


In carrying out my invention I have a boiler or trough so constructed that boiling water may be kept continually running through the same, and into this boiling-water I immerse the ham, so that it shall be subjected to the constantly-changing stream. This freshens the ham and nearly cooks it, and the process continuing from two to four hours, according to the size of the ham, is so gradual that the ham preserves its original shape and retains all its fiber and juices, which are subject to destruction under the other processes now in vogue. After the ham has been nearly cooked in this way it is withdrawn from the boiling water, and I skillfully remove the skin and bone, taking care not to remove or hack the fiber; then put it into a can of any convenient shape, the circular or cylindrical being preferred as best adapted for the purpose, and by soldering up the can hermetically seal the partially-cooked ham within the same. After the said ham has been so hermetically sealed up in the can, I then "process" it by submerging it in a chemical bath made by using chloride of calcium in the boiling water; or in lieu of that, when undesirable, I use dry steam under pressure, for the purpose of raising the temperature up to 260° for the first hour. I then gradually reduce the temperature to 230° for two hours, and further reduce the same to 212°, giving a total of about four hours to processing as aforesaid, which process keeps the ham much fresher and more palatable than the process of cooking hams in sealed-up cans or packages, either whole, boned, or cut up into small pieces, as is the case in the several methods of preparing cooked ham hitherto and now in vogue, all of which processes I disclaim.

Federal Regulations

The canning of meats entering interstate commerce differs from other food products in that it is covered by rigid regulations pertaining to every detail of production from the selection of the animal through the processing to labeling the container. One may not engage in this line of canning without first obtaining a permit or license from the proper federal authorities. The applicant must describe minutely the premises where the work is to be done, the buildings, equipment, state the character of the products to be packed, give the formula to be used, and outline the methods to be followed. He must subscribe to all the rules and regulations now in effect or which may be imposed in the future, make any changes in the plant or in the equipment which are deemed necessary, alter his formula or methods if so directed, and pay for the inspection service.

The Meat Inspection Act was passed by Congress June 30, 1906, and its enforcement placed in the Bureau of Animal Industry of the Department of Agriculture. That Bureau has prepared the rules and regulations relative to the conditions affecting packing plants and their operation and all other plants preparing or manufacturing meat products for distribution in interstate commerce, and for others desiring the service if they will comply with the requirements. The Bureau determines the qualifications of
the inspectors and supplies them as government agents to pass upon all animals intended for slaughter, conducts the post-mortem inspection, follows through the conditions of storage, the processes of preparation in manufacture, passes on all other raw materials used, the labeling, and the condition when delivered in trade. It naturally follows that meat canning is limited to slaughtering establishments, or to plants purchasing meats from abattoirs under inspection. The costs involved in plant equipment and for inspection make it necessary to have practically continuous operation to be a financial success. Operations cannot be seasonal or for short periods as in the case of fruits and vegetables.

Federal inspection of meats is concerned with three things; that the meat be from healthy animals fit for food; that the slaughtering of the animals and the subsequent handling of the meats in storage and manufacture be under sanitary conditions; and that the final product be sound and truthfully labeled. These are such reasonable requirements that nearly all local slaughter houses having enough business to justify an inspector voluntarily ask for the services and the same is true for packing establishments using meat products but not in sufficient quantity to necessitate inspection as in the packing of baked beans with pork. The inspection is a model of what a bureau can do when sticking to its particular field of protecting health instead of fussing on trade details such as whether a sausage containing 40 per cent of beef in a mixture be required to have a certain designation and another of like character but with 45 per cent of beef must bear a different label.

The precautions just cited might give the impression that meat is a particularly difficult product to sterilize because of some resistant organisms associated with it or that in the event they are not destroyed that serious consequences may follow. The facts are that the majority of all organisms, and the most resistant forms recovered from spoiled cans are the same as found associated with other canning operations. The most underrated factor as a cause of spoilage is the slow irregular heat penetration and another is the great variety of cans of irregular shape and size that are in use.

Unless the can contains free liquid or jelly which will be liquid when hot, the heat transfer is by conduction through the material, which is slow in undisturbed tissues like cuts of ham or corned beef and very slow in comminuted materials like sausage, potted meats, or corned beef hash. Even in filling cans some parts may be packed solidly and others be done rather loosely so that avoidance of spoilage therefore depends upon using what appears to be an excessively heavy cook for all. In products of this kind, heat penetration is greatly favored when the difference in temperature on the heating side of the can is several degrees higher than on the inside. The older processors took advantage of this and raised the retort temperature ten to twelve degrees higher than wanted at the start and then dropped back after a time as indicated in the Black patent already cited, so as not to carry the temperature above that which was wanted. In large pieces like ham, the product is not sterile, some organisms resist the heating but are rendered inactive and no harm follows.

The use of the great variety of cans is a factor which is generally ignored but multiplicity of sizes is accompanied by a higher proportion of leaks in both manufacture and in closing. That is in line with the history of all
canning. The use of the open top round cans might well supplant some of
the square cans and abandonment of many of the odd sizes to good ad-
antage. Meat packers, as a rule, have made all or a large part of their
cans though the tendency now seems to be toward letting the regular can
companies care for that business.

There is a general rule among meat packers to hold all canned foods for
thirty days or more as a precaution that no defective containers find their
way on the market.

While commercial operations are carried out under such careful safe-
guards, other government departments and state agricultural experiment
stations advocate home canning by methods which would be wholly inade-
quate in trade.

Canned Meats

The meats canned are beef, veal, mutton, lamb, and pork, either fresh,
mildly cured, or cured. To these have been added poultry since this item
has become of such large importance. The amount of game packed is al-
most negligible. It is preferred that meats for canning should be lean but
in good condition. Excess fat causes loss in cutting the carcass and also in
trimming the semi-prepared product, resulting in a poor appearance. Poor
carcasses are suitable only in comminuted products where they can be
mixed with fats and trimmings from other animals.

The number of canned products exceed a hundred but many of them are
in reality mixtures with different proportions of the meats, to differences
in seasoning, and to the form or style of packing. Meat packers have also
exercised initiative and individuality in preparing products to be marketed
under a brand and which do not conform strictly to the usual types.

Some of the more popular and better known preparations are:

Beef: Barbecue hash, beef broth, beef ragout, beef soup, beefsteak and
onions, beef stew, beef stew a la Carolina, beef stew Spanish style, beef
stock, Brunswick stew, consomme, corned beef, corned beef and cabbage,
corned beef hash, cottage beef, hamburger steak, Hungarian goulash, meat
loaf, oxtail soup, ox tongue, roast beef.

Veal: Veal broth, veal loaf, veal stew, potted veal. Calves tongue.

Mutton and Lamb: Mutton broth, mutton stew, Irish stew, lamb tongue.

Pork: Ham, half ham, quarter ham, deviled ham, potted ham, spiced
ham, loin roll, luncheon loaf, luncheon meat, pigs tongue. Sausage country
style, sausage Frankfurter style, sausage with cereal, sausage with sauer-
kraut, sausage Vienna style. Spareribs with sauerkraut.

Chicken: Chicken a la king, chicken boiled whole, chicken boneless,
chicken deviled, chicken fricassee, chicken livers, chicken potted, chicken
roast whole, chicken stew, chicken with noodles.

Preparation

The fresh carcasses are hung in the chill room for the length of time
deemed necessary to put them in the best condition for cutting and working
into the type of product wanted, which is generally from two to ten days
depending upon the size of the carcass, the temperature of the room, and
the judgment of the superintendent. For some purposes, frozen meats may
be used up to 180 days provided no ill effects are appreciable from freezing but ordinarily meats are worked through the packing house as rapidly as possible to save cold storage and other expenses.

Meat canning requires only a simple though special equipment. Heavy butchering tables and blocks are needed for cutting up the quarters, for removing the large bones, and dividing the meat into suitable pieces. Other tables are needed for handling the cooked meats as trimming tendon, gristle, fat, small bones, etc. It is particularly recommended that the latter should be covered with stainless steel or nickel since these metals have no appreciable action upon meats, are non-absorbent, afford the minimum of lodging for micro-organisms and are easily cleaned. There is less objection to wood in the butchering tables and blocks but doubtless the same measure will apply to these in the near future.

The cookers are of the jacketed kettle type or chests which may be closed for light pressure, in either case to be of aluminum or stainless steel. Copper and iron produce a distinct dulling effect on the meat and while this is unnoticed or accepted as normal in the home kitchen it gives rise to criticism in the commercial product.

The cutters, grinders, mixers, sausage stuffers, and filling machines are specially designed for the purpose, are heavy, strong, but simple by comparison with apparatus used in other lines. One of the aims in designing these machines is to make everything easily accessible for cleaning. Even with all these precautions some factories stop operations for a few minutes near the middle of the forenoon and afternoon to make a hot water spray or steam washing. The thin layer of grease and the drying of meat juices on the surface act as protective coverings for various micro-organisms and incidentally to increase their normal resistance, hence the advantage of the intermittent cleaning. Meat has been largely packed in rectangular cans, sealed and tipped in a vacuum chamber. This is giving way to regular open-top cylindrical cans as the latter can be closed with a vacuum in a high speed line. Some of the rectangular cans will doubtless persist since they are better suited to give the customary appearance or to fit certain cuts.

The preliminary preparation of meats follows the general procedure used in the kitchen as boiling, stewing, roasting, potting, making into sausages, chopping, and mixing with other materials as hash, obtaining extractives for soup stock, etc.

Boiled Meat

Boiled meat represents the simplest form of preparation for canning. The cuts of fresh meat are washed and placed in a metal box or basket and submerged in a tank of cold water and the heat brought to boiling very gradually. A batch of 100 pounds of beef or other meat requires from 30 to 35 gallons of water to which 3 pounds of salt are added. By using cold water and heating slowly to boiling a more uniform effect is obtained than if the pieces be dropped into boiling water. The slow heating favors the formation of a scum which floats to the surface and can be skimmed off readily. The cooking is carried on at a gentle boil or near the boiling point until the meat is fairly tender usually from 2 to 3 hours, or in some cases even more. In this process there is a shrinkage and loss in weight of about 25 per cent. A spice bag may be placed in the kettle with the meat but it is generally preferred that the final seasoning be left to the user.
The cooked meat is distributed to the tables and as soon as sufficiently cool it is trimmed of bone, tendons, cartilage, fat, blood clots, or any other spots. It is cut into pieces as nearly the size of the can as can be judged. The filling is most often done by hand, the effort being to have the pieces as large as possible, since small pieces are suggestive of the use of scraps.

One modification is to cut the flesh into pieces about one-fourth larger than the can and then boil as the smaller pieces cook more quickly and evenly though they break apart more in the preparation so are somewhat less attractive.

The fill of the can is completed by adding the necessary amount of small pieces and meat jelly. The jelly is made by boiling down the liquor, straining and adding jelly from the bones or gelatine.

The cans are exhausted or sealed in vacuum and cooked at 250° F. for 60 minutes for those weighing 2 pounds or less, and 90 minutes for those weighing 3 pounds.

Boiled mutton and other meat products are handled in a similar manner, making such variations as will give the most attractive product.

Stews

Stews naturally follow a very similar preparatory preparation as for boiled meats. The fresh meat is trimmed and cut into strips of a half-inch or more in cross sections and of convenient lengths, as two to three inches. More trimming stock and small pieces can be used than for the boiled. A batch of 100 pounds of beef requires about 35 gallons of water and 4 pounds of salt. After the meat has been slowly brought to a boil and skimmed a spice bag may be put into the kettle. The amount and kind of spicing is a matter of personal liking. A sample of such a mixture is coriander, 1 pound; black pepper and allspice, each 1/4 pound; bay leaves and cloves, each 2 ounces; and sliced onion, 8 pounds.

The beef is boiled slowly until fairly tender, which ordinarily takes from 1 1/2 to 2 hours, then add an equal weight of vegetables and other materials in such proportions as will give the desired result. The vegetable portion may be very simple as cubed potatoes, or a mixture of cubed potatoes and carrots. More pretentious mixtures may include cabbage, turnips, parsnips, celery, tomatoes, whole grain corn, lima beans, split peas, rice, pearl barley, spaghetti, noodles, etc. One thing which the packer has to take into consideration is that the mixture be well balanced, is of good appearance and flavor, and can be repeated at any time. The additions are made a sufficient time before the meat is done so that the different articles are partly cooked. For example, good potatoes may require about 15 minutes, carrots 30 minutes, and parsnips even longer. The mixture is well stirred near the end to get an even distribution of the various materials. It must cool thick and heavy, preferably without the use of added thickener such as flour or starch. The cook is 250° F. for 45 minutes for No. 2 cans or smaller.

The stew affords a wide latitude for the exercise of skill in presenting a really palatable dish instead of just a conglomerate mixture. There is only one way of arriving at such a combination and that is through trials.

Mutton Stew

Mutton or Irish stew is prepared from mutton following the same procedure as for beef stew but making the pieces of meat somewhat smaller.
For 100 pounds of meat there are prepared 125 pounds of cubed potatoes and from 5 to 6 pounds of onions. The sliced onions are boiled with the meat throughout the cooking process as is also the bag of spices. The potatoes are added about 15 minutes before the end of the cooking. The cook is the same as for beef.

**Meat Stock**

The basis for most good soups is a rich meat stock, which in turn requires that it be prepared from a good quality of meat and not just anything because it was part of an animal. Since the size of the pieces is not a matter of consequence they may be prepared from portions of the carcass not suited to furnish large size pieces and from trimmings. The meat is cut into pieces about an inch square and the batches made in the ratio of about 100 pounds of meat to 12 gallons of water. The batch is heated very slowly and kept at boiling from 4 to 6 hours, replacing the water of evaporation. At the end of that time the fat is skimmed from the surface, then the whole batch strained and filtered through a thick cloth, or the meat may be lifted out with a perforated dipper and a half pound of whites of eggs well beaten be stirred into the broth, boiled up for a few minutes and the whole passed through a strainer and filter bag. This gives a strong, nearly clear broth with little tendency to jelly.

The bones, the larger ones broken open, joints and feet are placed in a cooker, covered with water and boiled from 6 to 8 hours to obtain the gelatin and extractives. The bones are removed and white of egg added to aid in clarification as before, strained, and filtered. The resultant broth will form a heavy meat jelly upon cooling. The two may be mixed in the proportions desired to obtain body and flavor.

Salt, spices, including onion and other vegetables may be added in a bag during the cooking or not, as desired, or depending upon the use made of the stock.

**Roast Beef**

The stock selected is from animals in good condition and of the same grade as used for canned beef. All parts may be used except head meat, scrap meat, meat from shanks, flanks, or thin plates.

Roast beef is cut to fit the can as nearly as possible, making due allowance that the pieces will shrink about 30 per cent. The pieces are cut to the proper length, rolled and tied. The prepared pieces are next set on end in a pan, a small quantity of water containing one-fourth of a pound of salt to the quart is added. The meat may be sprinkled with pepper or other seasoning if desired. The pans are slipped into a hot oven for a half hour for pieces up to two pounds. The pans are drawn for basting to prevent drying of the surface.

The string is cut from the piece which is then slipped into the can. A thick gravy made from the pan grease is used to fill the interstices.

The cook on cans containing two pounds or less is 50 minutes at 250° F.

Roast veal and roast lamb are handled in essentially the same manner as beef.

**Corned Beef**

Canned corned beef was a natural development from the period when nearly all meats not consumed at once after killing were salt cured. It is a
variable product as the formulae are not standardized and nearly every packer has introduced some variation of his own. This is probably even truer for the canned article than for bulk stock since many devices are used to hasten the process or to use the meat before undergoing complete cure or maturation.

The preference is for the flesh from mature animals in good condition but not fat. After slaughter the carcasses are allowed to hang for a few days, then in cutting, the brisket, chuck, and plates are selected for the purpose though other large pieces may be used. The federal purchase specifications for the army, navy, and other institutions provide that the meat “Shall be cut from the best quality canner carcasses. Head meat, scrap meat, and meat from shanks, flanks, skirts, and navel end plates to be excluded.”

“Shall be thoroughly cured with no preservative other than salt, sugar, and saltpeter, but nitrate of soda or nitrite of soda may be used in lieu of saltpeter. Shall be properly cooked. The beef to be cured shall be free from blood clots, bruises, skin, stringy fibrous tissue, tendons and excessive fat. The finished product shall contain no excessive jelly or moisture. Shall be of good flavor and free from objectionable odor. Upon analysis, the finished product shall show not more than 3½ per cent of common salt and not more than two-tenths of 1 per cent saltpeter.”

The preparatory steps in securing such a product are to place the pieces of beef in layers in hogsheads, packing them evenly but not too tightly. Each hogshead will hold about 500 pounds of beef which is covered with a brine made in the following proportions: Salt, 20 pounds; saltpeter, 5 pounds; sugar, 5 pounds; nitrite (sodium nitrite may be substituted for part of the saltpeter at the rate of one part of sodium nitrite for five parts of the saltpeter); water, 12 gallons. To expedite the making of the brine, the solids are dissolved in about four gallons of hot water and allowed to cool and then added to the remainder to make the brine. The beef is covered with the brine.

At the end of a week the brine is drawn off, the meat is taken out and repacked and the same brine returned. At the end of another two weeks the meat is sufficiently corned to be used. This is about one-half the time required for complete curing and is in line with that used in some of the better brands of canned corned beef. The time can be shortened a few days by cutting the meat into smaller pieces, by packing loosely, by repacking on the fourth day and allowing ten days longer in which to cure.

The use of sodium nitrite dates from a patent No. 1,212,614, January 16, 1917, issued to George F. Doran, Omaha, Nebraska. The object is to supply the nitrite instead of waiting for it to be formed by bacterial action upon the nitrate as occurs in the usual curing of meat. It conserves the brighter color of the meat and the action is more uniform. This patent is supplemented by Nos. 1,259,376 and 1,259,377, March 12, 1918, by the same inventor and also by No. 1,957,150, May 1, 1934, issued to L. C. Paddock, Chicago, Illinois. The latter is a modification to permit the use on dry cured meats.

In a so called quick process, the meat is cut into smaller strips and these are filled into a trough and covered with brine. The trough being mounted on wheels is run into a retort, a vacuum is drawn to cause any gases or
air to escape from the interstices and tissues, followed by admitting air under pressure of about 25 pounds to force the brine into the tissues. The pressure is maintained for a half-hour or longer. This reduces the time from days to hours and it is said that the period can be made as short as twenty minutes. In the older or slower process the meat gives up some of its moisture and takes up salt by osmosis while at the same time other changes occur which are not so easily measured but which are vaguely understood as curing and which are lacking in the quick process.

Another simple quick cure method requires no special equipment but the meat is first parboiled and cured afterward and as soon as it is ready, is canned. The meat is cut into strips about one and one-half inches wide, washed, and plunged directly into boiling water, heated quickly to near the boiling point and allowed to simmer from 25 to 30 minutes. The meat must be gently stirred during this time so that the mass will be broken up to insure that each piece receive like treatment. The shrinkage is the same as for boiled meat, that is from 30 to 35 per cent. At the end of the heating the scum is removed.

The meat is lifted out into another tank for curing and this latter is equipped with a heating coil.

The liquor derived from the first batch is left in the tank and the next batch added and this may be continued for four batches, in fact, a preference is given to parboiling in broth rather than plain water. Experience has shown, however, that no batch liquor should be used more than four times nor should it be allowed to stand between working periods. Aluminum kettles are best for such work or in lieu of such kettles, aluminum cages or baskets in which to hold meat. The curing can be done in the same cooker but it is generally more economical to use special tank trucks. In the transfer of the meat to the holding tank the temperature soon drops to about 160° F. when it is covered with a brine heated to about the same degree. The brine is made up about as follows: water, 50 gallons; salt, 30 pounds; sodium nitrate, 12 pounds; sodium nitrite, 1 1/4 ounces. The meat in the pickle is stirred every five minutes for the first hour and every fifteen minutes thereafter; if the cure is to be finished within six hours, the temperature is kept to about 135° F., and if the batch is to be kept over night, the temperature is allowed to drop to about 120° F. after the first hour. The pickle is applied at the rate of about 10 gallons per 100 pounds of meat.

This process is based upon the fact that chemical action is more rapid at high than at low temperature, also that the action is more rapid in tissues which have been heated than in the raw. When the cure is complete as judged by the color and texture, the scum is removed by skimming or flushing with water. The pickle is drawn off and replaced with warm water for about a half-hour to remove the excess of surface salt.

The meat is turned out upon the trimming table where the sinew, tendon, cartilage, and other objectionable parts are removed, and the strips cut for filling by hand or machine. Small cans are best filled with a stuffing machine as it gives greater uniformity than by hand. Meat jelly may or may not be added, and the cans checked by weight. Any loose filling which leaves spaces between pieces will show discoloration in the finished product.

Beef taken out of the regular pickle is given a brief wash and placed in the cooker, cooked either in water or by steam, the latter being somewhat
the simpler. The time will vary from 20 minutes to 1 1/2 hours but usually between 40 and 50 minutes, depending upon the size of the pieces but in all cases it should be sufficient to release any surplus water so that when packed in cans the fill will be solid meat with no appreciable amount of water. The meat is delivered to the trimming table and treated as already indicated for the quick process. The meat for the smaller cans is cut into strips about one inch in cross sections and for large cans it may be double that. The strips are fed into the machines which fill the cans automatically, and from which they pass over the weighing machines which separate over and under weight cans into their respective classes for correction. The cans are sealed in vacuum or they may be exhausted and closed in the regular way.

The cook on cans holding 12 ounces or less of meat is 2 hours at 235° F. and for more than 12 ounces but not exceeding 24 ounces, 2 1/2 hours. An alternative is to use 240° for 80 and 100 minutes respectively, but the preference is for the lower temperature. The meat used in packing 5 and 6 pound cans is generally of heavier pieces with more time allowed in both the pickle and parboiling, also necessitates 4 hours for the 5 pound can, and 5 hours for the 6 pound can when cooking at 235° F.

All cans are washed in a hot alkali solution on being removed from the retort, rinsed under strong sprays of hot water and then cooled.

Corned Beef Hash

The meat portion of corned beef hash is prepared as just described. In addition, sound potatoes of suitable character are peeled and boiled until about half cooked and in amount to make 46 per cent of the batch, also sound onions free from sprouts are skinned and trimmed, to the amount of 3 per cent of the batch. The meat, potatoes, onions, and spices are next put in the cutter and chopped into small pieces but not mashed into a smooth paste. The mixture is filled into cans and should be moist but not sloppy. It is exhausted to 130° F. or above, sealed and cooked for 55 minutes at 250° F. for 12 ounce cans and an increase in time for larger sizes.

The government specifications make this requirement: “The proportion of ingredients shall be approximately 51 per cent corned beef, 46 per cent of potatoes, and 3 per cent of onions, all of which shall be properly and uniformly hashed in accordance with standard practice, spiced and thoroughly mixed so as to produce a product of mild, pleasing flavor, good bright color, with no evidence of free liquor.”

Tongues

Tongues are cured in a sweet pickle similar to that used in the making of corned beef but the proportions of nitrate of potash or saltpeter may be slightly increased. Small tongues as pig, lamb, and veal may be overhauled on the fifth day and be sufficiently cured by the fifteenth day but beef tongue is very firm and needs the full three weeks.

Pig and lamb tongues are drawn from the pickle and soaked in cold water overnight, are then put in the cooker with cold water, slowly brought to a boil and cooked for two hours. The tongues are skinned, the bones removed and the base trimmed so that it looks well. Tongues are packed in flat cans and are laid so they will fit the curve. The interspaces are filled with veal jelly. One pound cans are cooked for 60 minutes and 2 pound cans 90 minutes at 250° F.
Tongues make an attractive package in flat glass jars and are handled in the same way except the cooking temperature is generally 240° F. and the time extended a half hour.

**Potted Meats**

Potted meats are cooked ground meats to which some ground salt pork is usually added and well spiced.

Beef is prepared as for boiled beef and cooked until tender, trimmed, and cut into pieces about an inch square. Well cured salt pork is prepared separately, first washing well, then soaking in cold water about six hours, changing the water two or three times or it may be over night if the water be not changed. The pork is transferred to fresh water and gradually brought to a boil and cooked from 2 to 2½ hours. The pork is skinned and cut into pieces corresponding with the beef and the two mixed together in the proportion of about 78 to 80 per cent of beef to 22 to 20 per cent of pork. Spices are sprinkled over the meats while they are being mixed if run through an Enterprise grinder or Buffalo cutter, the amount and proportions of the various ingredients being very important in producing a pleasing product. Finely ground pepper, sweet paprika, and coriander are usually present in liberal quantities, as at the rate of a half-pound each to the hundred pound batch. It may be necessary to add about one and one-half per cent of salt for flavor and some water to get the proper consistency. The mixture is heated in a jacketed glass-lined or stainless-steel kettle before transferring it to the filling machine.

Potted meats are most often packed in small cans, one-fourth of a pound or less and cooked at 250° F. for 40 minutes or half-pound cans for 50 minutes.

Potted tongues consist of salt cured or smoked tongue of the kind designated, soaked in cold water for six hours or more, brought to a boil in fresh water and cooked until tender, skinned and trimmed and cut into pieces. Salt pork is prepared as already indicated and in this case the proportion is higher, constituting from 25 to 35 per cent of the batch. Spicing is done as for beef as also the subsequent cooking in the can.

Potted ham is most often prepared from large hams or shoulders. The meat is trimmed, skinned, and the heavy or thick fat cut away though most of it is used in the ground product. The hams are then placed in cold water and heated slowly and kept simmering for about five hours. The bones are cut out and the meat cut into pieces for the grinder. If the meat be extra fat, the addition of some ground tongue serves to take up some of the fat and gives the mixture a dryer appearance. Ham requires a heavier spicing than other potted products. The subsequent operations are the same as for other potted meats.

Potted chicken, duck, turkey, etc., is made with about 90 per cent of the fowl which it purports to be and 10 per cent of salt pork. The birds are cleaned, drawn, cooked until tender, boned, skin and excess fat removed, and the meat and pork mixed before grinding.

**Sausage**

Sausage is one of the very important meat products, prepared after more different formulae and in more different forms than probably any other food except cheese. Christofaro di Messisbugo, who in 1549 published the
most important work upon the cuisine in the sixteenth century, laid much emphasis upon sausage as one of the most satisfactory ways of preparing meats. Many persons think of sausage as simply one means of merchandising the less attractive parts of a carcass or that which cannot be prepared so conveniently or without waste in the kitchen. Few realize that some large companies convert thousands of choice carcasses annually to sausage to supply the demand or that the variation in the price per pound on this product is wider than on the lowest and highest priced cuts of meats.

Data are not available on the amount of canned sausage marketed but some mental picture may be formed of what happens in one factory where a single cooker turns out 300 finished cans per minute.

Sausages vary greatly as pure pork or beef, mixtures of these meats and also of other meats and in the proportion of such mixtures, in the use of fresh, cooked and cured meats, the character of the cutting of the meats, in seasoning, addition of cereal, type and size of casing, smoking, etc.

Canned sausages are most often packed in small casings of the Vienna or Frankfurter type and made of a mixture of beef and pork.

Vienna Sausage

The federal purchase specifications for this style of sausage contains the following: "Shall be made from fresh (uncured) beef and fresh (uncured) pork trimmings in the following proportions: Beef trimmings, 60 to 40 per cent; pork trimmings, 40 to 60 per cent.

"Pork trimmings shall run from 40 to 60 per cent trimmable fat. Beef trimmings shall be free from gristle, ligaments, and excessive connective tissue. Bruised and oily pork trimmings and pork trimmings from heads and seedy parts of bellies shall be excluded. Meat that has been frozen may be used, provided it has been under refrigeration in the freezer not longer than 180 days, shows no evidence of refreezing or deterioration, is of good color, and is otherwise in good condition. All meat shall be in prime condition at the time the product is manufactured. To each 100 pounds of beef trimmings there shall be added 3 pounds of salt and 2½ ounces of saltpeter (not more than 2 ounces of nitrate of soda, or not more than one-half ounce of nitrite of soda may be used in lieu of saltpeter); beef trimmings shall be held under moderate refrigeration for a period of from two to six days just previous to use. To each 100 pounds of pork trimmings there shall be added 2½ pounds of salt at the time the trimmings are mixed with the chopped beef. Water or ice may be added, provided that the finished product shall not contain added moisture in excess of 10 per cent. The addition of cereal, potato flour, or similar substances, artificial coloring matter, or any organ or part not specified herein, will not be permitted. The meat shall be finely ground and properly seasoned. Sausages shall be stuffed into sheep casings or molded in an artificial casing or other type of mold approved by the Bureau of Animal Industry of the United States Department of Agriculture as specified in the invitation for bids. Product shall be thoroughly smoked. There shall not be less than 26 nor more than 35 full-length pieces to a 2-pound can (same proportion to apply if larger or smaller can is specified); diameter of pieces in each can to be cut approximately the same; both ends of each piece shall be square cut."
In the making of this type of sausage the trimmings, cut into conveniently small pieces, are usually ground in the screw type of grinder with the cutter working against a perforated plate. This gives a very finely comminuted almost a pasty effect. Some manufacturers prefer to use the sharp chopping knives which cut the meat into very fine pieces as it produces a slightly different effect when being eaten. The proper quantity of each kind of meat is delivered into the mixing machine and the spices added. Salt and white pepper are always used but there is wide latitude on such additional spicing as coriander, paprika, celery seed, and garlic. The matter of spicing differs with each house and is a very important factor in gaining popularity for any brand.

The meat is filled into small sheep casings, the links are about two feet long as that is about the limit that can be filled without breaking. These links are hung on sticks which again are placed in racks and moved in a room to dry for a few hours. As a next step they are carried into the smokehouse where they are subjected to a hot smoke at about 130° to 135° F. for from 30 to 45 minutes and then allowed to cool until the next day.

The links are cut so that they will fit into the can without waste head-space. The end bits are packed separate. A sufficient amount of meat jelly, meat broth, or brine is added to fill the interspaces. The cans are exhausted to a temperature of 150° F. or sealed under vacuum. The cook is at 240° F. for 18 minutes in the continuous agitating cooker or 25 minutes in the regular style of retort.

Frankfort Sausage

This type of sausage is all pork, about 70 per cent lean and about 30 per cent fat, preferably made from pigs or young hogs which are not excessively fat.

The cut meat is weighed and run through a grinder and then placed in the mixer with salt, pepper and other spices added. The stuffing is done in small sheep or pig casing, preferably not much more than a half-inch in diameter. The links are generally about two feet in length and are handled nearly the same as the Vienna style of sausage. The smoking is done at a low temperature, preferably around 70° F. and continued for about twelve hours or until the sausages have attained a reddish-yellow color. They are boiled at once, the time being from 20 to 25 minutes, depending on the size. They are allowed to cool and then packed in the cans and completed the same as previously described.

Country Style Sausage

An all pork sausage with sufficient fat to be rich but not greasy and ground through a medium plate so that it is free from appreciable chunks but not too fine. Salt is added at the rate of 2 1/2 pounds per hundred of meat. Pepper, allspice, and other dry spices are used or not as desired. Sage is a favorite spice for this style in many localities.

The cans are filled by machine but owing to the poor conduction of heat it is preferable not to exceed the one pound capacity. The cook is 90 minutes at 240° F.

Tamale

The tamale is a Mexican style of food preparation consisting essentially of a dough made from corn meal, chopped cooked meat or chicken, and
thick chilli sauce, the whole being wrapped and tied in corn husks. It is a very important item in Mexican cooking, doubtless having its basis in the native Indian corn, chilli, and meat mixtures used before the advent of the Spaniard but modified by the latter in accordance with his mode of cookery under the primitive conditions of the country. Naturally there are variations in details of composition and in the manner of making as may be gathered from different cookbooks. *La Cocinera Poblana*, published in 1913, gives twenty-four recipes. Further modification has also been made in order to can the article and make it more generally available.

The tamale is growing in popularity among the people of the southwest and west as they become accustomed to Spanish dishes and especially with immigrants from southern Europe.

The native method requires that the shelled corn be boiled in saturated limewater until the hull splits and loosens, stirring to detach the hulls, washing them out, and draining. This is simply a modification of the eastern method of making lye hominy and many Mexicans now use ashes or lye to aid in this step. Next the grains are mashed between two stones, one flat and the other long and more or less cylindrical like a rolling-pin. The result is a coarse stiff corn meal paste which may require the addition of some chilli sauce to give it the proper consistency. Clean inner corn husks which have been previously boiled and dried are now spread on a board covering a space equal to the length of the husk and overlapping each other to make about eleven inches in width. The dough or paste is now spread across the middle third or more of the husks and to the thickness of slightly less than a quarter of an inch. On this is placed the meat, which is preferably chicken or fowl but may be beef, veal, or a mixture of meats, and the whole covered with thick chilli sauce. The sauce is made of about a half-pound of ground chilli pepper to a gallon of stewed tomatoes, one-half pound of onions, a clove of garlic, and salt to give the proper taste. The whole is cooked until it is of a creamy consistence. The husks are now rolled into a cylinder about two and a half inches in diameter and the husks tied tightly at each end just beyond the paste. The result is a short roll weighing from 6 to 8 ounces. It is cooked in oil and may be served hot or cold.

Whatever may have been the reason for using the corn husks for wrapping, it is regarded as an essential part by the Mexicans in contributing a distinctive sweetish taste.

This style of tamale is canned, one in a No. 2 can, care being taken to have the tamale made to fit the can, but since it is not economical to prepare and carries a high proportion of inedible waste, it has not met with hearty approval among packers.

A special form of canned tamale was invented by Julius Bunzl, San Francisco, California, in 1897, and for which he received a patent, No. 620,084, February 21, 1899. The important paragraph is as follows:

> The object of my invention is to prepare the same ingredients which are used in the manufacture of these Mexican tamales in such manner and by an improved process and method of canning by which they can be put up and hermetically sealed in tin cans, and thus sold as a new canned product. In order to do this, I take corn in the grain and boil it until it has been perfectly cooked, after which I allow it to become dry and hard either by evaporation or by natural drying process. If desired, a small quantity of lime or soda may be added to the water in cooking the corn; but this is not absolutely necessary. I then take the dried corn and grind it to a meal. Then I take this meal and mix it with a small quantity—say two ounces—of lard to a pound of meal,
and then add hot water and mix and knead it until it is reduced to a dough or paste. This dough or paste is then evaporated until the water it contains is abstracted, and then I take a portion of it and spread or plaster it in a thin layer upon the bottom and sides of the can in which the compound is to be sealed. This leaves the central portion of the can open to receive the chicken, sauces, etc. Theinside ingredients consisting of bits of cooked chicken, fowl, or other meat, are mixed with the chilli sauce which is prepared in the usual way, and after the addition of such spices and fruits, the latter usually olives, the interior cavity in the can is filled to near the top with the latter compound. I then fill in the top of the whole layer with meal dough above described and hermetically seal the top of the can. This tamale compound thus prepared and sealed will keep an indefinite length of time in a perfectly fresh and sweet condition. When it is to be used, the preferable way is to place the can in hot water and allow it to remain until the whole has become thoroughly heated through before opening the can, this heating operation causes the meal dough to absorb the sauces from the interior so that it will furnish a perfect canned substitute for the Mexican tamale.

No headway was made with this style of packing until 1915, when C. H. Workman devised a machine for lining the cans with the cornmeal paste and modified a filling machine to fill the interior, thus eliminating much of the labor. This style of packing immediately became popular under well directed publicity and others naturally paid the compliment of imitation.

In 1912, another style of packing was developed retaining in the main the same ingredients but changing the mixture and form in details so that the work might be done by machines.

A special machine was developed consisting of two parts, one to handle the meat and sauce or filler, forming it into a continuous flattened cylinder, and the other part forming the dough into a tube which would surround or enrobe the meat and sauce mixture, the two being simultaneously ejected from their respective nozzles to make a complete tamale and pinched off at a predetermined length.

In order that the machine might work, the meat had to be finely ground instead of being in small chopped pieces and the sauce made with the minimum of moisture so that when mixed with the meat the two would hold together. The cornmeal was also stiffened by adding about twelve per cent of flour.

The tamale was next wrapped in corn husk or parchment paper and packed in the cans like stuffed sausages and the space between filled with meat stock, a part of which would be taken up by the filler and a part by the paste so that in the complete product the consistence would be normal. Salt is added to the stock.

The cans are exhausted to 130° F. or above and the cook is 70 minutes for the No. 1 can and 85 minutes for the No. 2 can at 240° F.

A recent modification of the method has been to use cellophane instead of corn husks for enclosing the tamale before packing it in the can.

POULTRY

The domestication of wild fowl seems to have originated in China or southern Asia a very long time ago and the various fowls brought westward about 1000 B.C. They were distributed in the Mediterranean countries by the Greeks about 500 B.C. and were fully established in southern Europe in the Christian Era. The Chinese were the first to fully appreciate the value of fowls for both flesh and eggs, and utilized them for centuries
ahead of other peoples. The Europeans considered them as an adjunct to the home for ornament and to afford an occasional delicacy for the table rather than as an economic asset.

The hen or barnyard fowl proved itself to be the most adaptable for living under domestication, to be prolific and a good producer of eggs, so naturally became the favorite. The duck and goose were by nature better suited for the marshy countries and found use accordingly. Other birds were tried with limited success. The turkey is the American contribution in this field, having been introduced into Europe early in the sixteenth century.

All these birds, particularly the chicken, have proven plastic in the hand of the breeder so that there are hundreds of breeds varying markedly in their characteristics, in usefulness as producers of eggs or carcass, to the purely ornamental.

Chickens, ducks, and geese were brought to this country by the early immigrants, they were treated as adjuncts to the home farmyard but of almost no commercial importance until about 1820, and then only in the neighborhood of cities such as New York, Boston, Philadelphia, and Baltimore. The growth continued to be very slow and received its first stimulus as a result of the Civil War. The year following, 1866, there were sold on the New York market, a total of 150,000 barrels of dressed poultry. Each barrel contained 10 dozen fowls and that became the standard for shipment for years. The fact that the volume was so large and heavy that handling was accompanied by damage did not even serve as a corrective. The keg was introduced but as a unit to meet the requirements of the smaller retailer who could not handle 250 pounds at one time. The box did not come in until 1910 and the barrel has not wholly passed out, though it is no longer used except for the lowest grades.

Poultry occupies a very important place in American agriculture, the products having a value above that for either cattle or wheat and nearly double that of all the fruits. More persons are engaged in poultry production than in any other agricultural activity as it is shown that some kind of fowls are grown on 85 per cent of all farms.

The poultry industry has been completely changed since the enactment of the federal pure food law in 1906. The enforcement of that law to eliminate the shipment of unfit dressed birds and eggs to market, naturally traced the cause of unwholesome products to their source and corrective measures necessitated changes in practice and a reorganization of the methods of handling from the farm to the consumer.

Canned Chicken and Other Fowl

The preparation of canned chicken and other poultry begins on the farms. The birds are bought on the basis of their age, condition, breed, and grade, that is, their suitability for certain purposes. At the collecting stations the birds are separated, certain grades to go to the live market, others to be confined and fed from ten to twenty days, and still others to be killed and dressed locally or shipped to a killing station. The purchase on the basis of quality eliminates most of the unsuitable birds, differences in price result in better preparation for the market, and provision for confined feeding secures a finish not attainable in any other way.
Killing stations are generally located within easy trucking distance of the collecting stations to reduce injury to the minimum and also shrinkage from shipping.

Dressing poultry consists first in preparing the bird by a twenty-four hour fast but permitting access to water. This results in an almost complete evacuation of the intestinal canal. The bird is suspended by slipping each foot through a shackle, the head is held in the left hand and pressure applied to each side of the mouth to cause it to open and the killing knife inserted so as to sever the vessels at the point where the head connects with the neck and as the knife is drawn forward a second thrust is made to pierce the brain. The combination movement results in almost instant death, free bleeding, and temporary loosening of the feathers. The cutting inside the mouth also eliminates any outside mark or stain. A knife with a strong short blade is used.

Formerly dry plucking was the vogue and is still followed in many places. This must be done as soon as the fowl has stopped bleeding and before any cooling of the body. The feathers can be drawn with the least damage to the skin at that moment. The tail and wing feathers are first pulled, then the larger feathers on the back, and the body feathers taken by a combined rubbing and pulling movement. The work is done rapidly and then finished by picking the pin feathers. The birds are then wiped with a damp cloth to remove dry skin scurf and flatten the hairs to the body. They are next hung on racks and run into a room at about 34°F. to thoroughly chill but not freeze them: the hanging time is generally between 24 and 48 hours before packing.

The scalding method consists in dipping the chicken into hot water, about 165°F. for about one-half minute and then pulling the feathers. The appearance of the bird is improved if, in the immersion the feet and head are held on hooks so that they remain out of the water. If the water be too hot, the skin will break and produce a bad appearance. The time needs to be gauged by the age of the bird. After the bird is plucked, it is plunged into water at about 165°F. for a few seconds, then submerged in cold water for two hours or more as it improves the appearance. The skin is made brighter, a little plumper, and freer moving on the body. The skin is dried with a cloth and the bird hung in the cooler at about 34°F. but not frozen. Scalding is used only when the birds are dressed for immediate marketing.

The more recent method is known as the semi-scald, that is, the birds are immersed in water at between 125° and 130° F. for 30 seconds. It causes loosening of the feathers so they can be picked more quickly and more cleanly than by the dry method and the pin feathers come away much easier. Moreover, there is less danger of drying to the skin. The picking of the feathers is the same as by the dry process but must be followed by immediate wiping to insure a dry skin. The birds are then chilled.

The chilled dry pluck and the semi-scald birds are next graded according to marketability. The heads are wrapped and the wings and legs folded to present the best appearance. They are boxed in single layers, a dozen to a box—or in double layers, two dozen to the box. Age, evenness in size, weight, color, finish, and mechanical workmanship in preparation are all factors which enter into the final steps so that marketing is upon a strictly
standardized basis. The birds are delivered as fresh dressed, fresh hand chilled, or frozen. The boxed birds are frozen at a temperature of about 15° and then held at about 25° F.

The delivery of birds undrawn is based upon the result of work by the Bureau of Chemistry. It was found that opening the body resulted in more infection than from movement of the organisms from the intestinal tract into the tissues and that this is particularly true if the precaution be taken to prevent feeding during the twenty-four hours prior to slaughtering.

Whole Chicken

The steps in canning whole chicken, either boiled or roasted, is to select birds of about uniform size and weight, preferably with short, plump bodies, in good condition, but only moderately fat. The best weight is from three to three and one-half pounds and not more than a year old. Much more care is needed in the selection than for fowls which are to be boned.

The first operation is to singe the birds and this is most conveniently done by hanging by one foot and using a wide but not hot gas flame on a hand burner. The flame is moved over the body quickly, effectually getting rid of the hair. Inspection is also made for any pin-feathers which may have been missed in plucking. The bird is opened and the viscera drawn, both the bird and viscera being kept in a shallow pan to be passed before the inspector. Keeping the two together prevents any error in identifying the proper carcass in case of disease. The liver, gizzard, and heart are trimmed and washed, the head and feet are cut off, the cavity washed out to remove any blood spots, and the trimmed parts returned to the cavity. The legs and wings are folded in such position that the bird fills the can with the minimum of waste space. In the case of roast fowl, the position is fixed by tying and the same is true for birds given a preliminary boiling before placing them in the can. Roast birds are placed in large pans and put into a moderately hot oven for about twenty-five to thirty minutes, long enough to get a light roasting effect. The skin should be slightly browned and dried but not cracked or peeled. The birds need to be basted about three times to preserve the best appearance and prevent surface drying.

Upon being taken from the oven, the birds are placed in cans and the surrounding space filled with hot jelly. If the work be done rapidly, no exhaust is necessary.

Deep oval cans have been designed to hold the chickens with the minimum of waste space and two or three sizes suffice for packing. A special closing machine is available so that soldering is unnecessary. Plain tin cans are used.

A variation is to stuff the fowl with chestnuts, mushrooms, or other distinctive dressing but in such event the stuffing should not be pressed too tightly as the heat penetration is slow and sterilization may not follow in the time required to sterilize the fowl. An added precaution is to have the dressing hot when filling the bird.

Boiled Chicken

The preliminary steps are the same as in the preparation for roasting. The boiling may be done in a jacketed kettle until the flesh shows some tenderness and the fat begins to collect on the water. The bird is then
ready to be put into the can and the filling be completed with jelly. Another method is to place the bird in the can and run the can into a steamer for about thirty minutes, draw it out of the steamer and fill the can with a 10 per cent gelatine. The heavy gelatine is needed as it becomes diluted by the condensate from the steam, and moisture from the body in the subsequent cooking. Of these two methods the preliminary boiling in the kettle gives the better results as some fat is cooked out giving a less greasy appearance and the whole body has a bright firm appearance. A still less troublesome method is to pack the bird in the can, add hot water, and exhaust for twelve minutes and seal.

The cook on whole birds will naturally vary with the size, the amount of preliminary cooking, and whether stuffed or not. For the average roasted or kettle-boiled bird unstuffed, the time is from 65 to 75 minutes, and if stuffed, from 90 to 100 minutes at 240° F. The safe procedure is to keep near the upper limit and work downward by experiment to determine the best combination for appearance and safety. A bird which has not had a preliminary cooking will require about 15 minutes additional time in the retort.

**Boned Chicken**

The inspected fowls are divided to preserve the meat in the largest possible pieces; leg and thigh, breast, wings, and body. One hundred pounds of pieces are placed in a kettle with sufficient cold water to cover and 2½ pounds of salt added. Spices may or may not be suspended in a bag.

The kettle is slowly brought to a boil and then kept in light action until the bones can be separated from the flesh without difficulty, which is usually about an hour and a half. When the boiling is finished and the liquor becomes quiet the fat is skimmed off and saved. The pieces of fowl are ladled out into pans to cool, the broth is reduced to about one-half or less and strained to remove the suspended particles. The clear portion is returned to the kettle and gelatine added to make jelly to be added to the meat.

The skin, bones and large pieces of fat are removed from the meat and the large pieces packed into cans, dividing it about equally between the light and dark meat, the interstices are filled with jelly. Round open-top cans are the most convenient in this instance. The cook is 40 minutes at 240° F. for those weighing 12 ounces or less.

The small pieces of meat are reserved for potted chicken. The skin and bones are returned to the kettle for two hours or more to extract flavor and nutritive matter. The liquor is strained off and any bits of meat not otherwise used are added and it becomes stock for rice, noodle, or other soup. Or if preferred, diced vegetables may be added as part of a stew.

**Squabs**

The procedure with squabs is similar to that just described but in this case cylindrical cans are chosen and of a size to hold one or two birds.

**Literature**

The literature upon meat canning is very meager considering the importance of the industry and its value in commerce. It consists chiefly of short articles scattered in trade, food, and other journals, are not easily accessible. The secrecy which attended the operations was responsible for
this condition as well as for the delay in research. What studies were made remained as confidential information in the hands of the firm supporting the investigation.

Of the books upon canning, "The Secrets of Canning" by Ernest F. Schwab, Baltimore, 1899, and "Recipes for the Preserving of Fruit, Vegetables, and Meat" by E. Wagner, London, 1908, have only brief chapters. "Modern Practice of Canning Meats" by G. T. Hamel, St. Louis, 1911, is the first to give fairly detailed directions for commercial operations. "A Complete Course in Canning," The Canning Trade, Baltimore, 1911, '14, '19 and '24, gives numerous formulae for different products which are suggestive to packers, and "Douglas's Encyclopedi"a by William Douglas, London (1905?), is a comprehensive work upon meat packing at that time and gives more concerning English and Continental packing than any other source.

The earliest research was along the lines of chemical composition of the finished products or of the major changes which might take place during the preparation. This was started abroad in the '80s and '90s but the major work done in this country was about 1900, and the results published by the Bureau of Chemistry as part 10 of Bulletin No. 13, "Foods and Food Adulterants," in 1902. The data are summarized in "Foods and Their Adulteration" by Dr. H. W. Wiley in 1907.


The matter of research was taken over by the National Canners Association in 1928 but only brief reports on progress have been presented at the annual meetings. The most important paper is by R. J. Thompson on "Heat Penetration Studies on Canned Meats," published in The Canner, Feb. 23, 1929, pp. 168-171.


The work done by the Institute of American Meat Packing is covered in "Readings in Packing House Practice, part III, pp. 54-68, Chicago, 1933. This is the special industry organ of the Institute and deals particularly with the technology of preparation.


THE CANNING OF FISH

If one of the original objectives in canning were to make better foods available to the seafaring, it also had the reciprocal effect of making sea-foods available to the vast population living long distances from the source of such supplies. The sailor needs fruits and vegetables in his diet to give proper balance in protecting his health. The fruits and vegetables need to be fresh or to have the same qualities as the fresh and which is most nearly attained in the canned. The landsman in many places likewise needs sea-foods to supply certain salts, as iodine, to prevent deficiency diseases as goiter, and both groups are better for having variety to stimulate appetite as well as to furnish body energy.

It is of interest that from the very beginning, both abroad and in this country, the first canneries were established along the coast and that marine products constituted a very large part of the commercial pack.

The importance of the industry at the present time is disclosed by the statistics from the United States Bureau of Fisheries and the relative importance of the several lines as expressed in percentages of both the cases packed and their value.

Comparative Packs and Values of Canned Fishery Products Packed in the United States

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1921</td>
<td>1922</td>
<td></td>
<td>1923</td>
<td>1924</td>
<td></td>
</tr>
<tr>
<td>Salmon</td>
<td>3,599,747</td>
<td>$28,867,169</td>
<td>61.9</td>
<td>5,234,898</td>
<td>$38,420,717</td>
<td>63.5</td>
</tr>
<tr>
<td>Sardine, Me.</td>
<td>1,399,507</td>
<td>3,960,919</td>
<td>8.5</td>
<td>1,869,717</td>
<td>5,750,109</td>
<td>9.2</td>
</tr>
<tr>
<td>Sardine, Cal.</td>
<td>398,668</td>
<td>2,346,446</td>
<td>5.</td>
<td>715,364</td>
<td>3,361,480</td>
<td>5.6</td>
</tr>
<tr>
<td>Tuna</td>
<td>549,150</td>
<td>3,074,626</td>
<td>6.6</td>
<td>672,321</td>
<td>4,511,873</td>
<td>7.5</td>
</tr>
<tr>
<td>Shrimp</td>
<td>655,364</td>
<td>3,804,781</td>
<td>8.</td>
<td>579,797</td>
<td>3,064,087</td>
<td>5.</td>
</tr>
<tr>
<td>Oysters</td>
<td>442,086</td>
<td>2,179,271</td>
<td>4.7</td>
<td>505,973</td>
<td>2,423,616</td>
<td>4.</td>
</tr>
<tr>
<td>Clams</td>
<td>1,166,507</td>
<td>3,804,781</td>
<td>8.</td>
<td>1,716,365</td>
<td>4,121,389</td>
<td>2.8</td>
</tr>
<tr>
<td>Other Fish</td>
<td>1,234,990</td>
<td>1,216,700</td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,402,960</td>
<td>45,533,573</td>
<td>62.9</td>
<td>6,253,577</td>
<td>42,401,602</td>
<td>58.8</td>
</tr>
<tr>
<td>Sardine, Me.</td>
<td>1,272,277</td>
<td>5,288,865</td>
<td>7.3</td>
<td>1,869,925</td>
<td>7,191,026</td>
<td>9.9</td>
</tr>
<tr>
<td>Sardine, Cal.</td>
<td>1,100,162</td>
<td>4,607,931</td>
<td>6.3</td>
<td>1,367,139</td>
<td>5,445,573</td>
<td>7.5</td>
</tr>
<tr>
<td>Tuna</td>
<td>817,836</td>
<td>6,914,760</td>
<td>9.5</td>
<td>652,416</td>
<td>5,756,586</td>
<td>7.9</td>
</tr>
<tr>
<td>Shrimp</td>
<td>700,429</td>
<td>4,381,534</td>
<td>6.</td>
<td>718,517</td>
<td>4,608,950</td>
<td>6.4</td>
</tr>
<tr>
<td>Oysters</td>
<td>524,544</td>
<td>2,720,073</td>
<td>3.9</td>
<td>447,481</td>
<td>2,478,044</td>
<td>3.4</td>
</tr>
<tr>
<td>Clams</td>
<td>1,710,616</td>
<td>4,381,534</td>
<td>6.</td>
<td>2,161,389</td>
<td>2,121,419</td>
<td>3.1</td>
</tr>
<tr>
<td>Other Fish</td>
<td>1,287,853</td>
<td>1,216,700</td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,018,550</td>
<td>47,369,507</td>
<td>58.8</td>
<td>7,488,620</td>
<td>56,219,306</td>
<td>65.2</td>
</tr>
<tr>
<td>Sardine, Me.</td>
<td>1,870,786</td>
<td>6,716,701</td>
<td>8.3</td>
<td>1,717,537</td>
<td>6,727,388</td>
<td>7.8</td>
</tr>
<tr>
<td>Sardine, Cal.</td>
<td>1,714,913</td>
<td>6,380,617</td>
<td>7.9</td>
<td>2,093,278</td>
<td>7,807,404</td>
<td>9.</td>
</tr>
<tr>
<td>Tuna</td>
<td>1,102,471</td>
<td>8,499,080</td>
<td>10.5</td>
<td>851,199</td>
<td>5,282,283</td>
<td>6.1</td>
</tr>
<tr>
<td>Shrimp</td>
<td>735,714</td>
<td>3,782,819</td>
<td>4.7</td>
<td>732,365</td>
<td>4,122,092</td>
<td>4.8</td>
</tr>
<tr>
<td>Oysters</td>
<td>654,755</td>
<td>3,721,159</td>
<td>4.6</td>
<td>413,834</td>
<td>2,026,569</td>
<td>2.4</td>
</tr>
<tr>
<td>Clams</td>
<td>1,850,378</td>
<td>1,850,378</td>
<td>2.3</td>
<td>2,003,548</td>
<td>2,003,548</td>
<td>2.4</td>
</tr>
<tr>
<td>Other Fish</td>
<td>2,256,877</td>
<td>2,256,877</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Continued on page 785)
**APPERTIZING**

### Comparative Packs and Values—Continued

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1927</td>
<td>6,565,179</td>
<td>41.9</td>
<td>$45,728,761</td>
<td>56.2</td>
</tr>
<tr>
<td>1928</td>
<td>6,926,808</td>
<td>44.3</td>
<td>$54,638,143</td>
<td>56.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sardine, Me.</td>
<td>1,262,124</td>
<td>10.2</td>
<td>5,249,030</td>
<td>6.4</td>
</tr>
<tr>
<td>Sardine, Cal.</td>
<td>2,563,146</td>
<td>20.8</td>
<td>9,368,784</td>
<td>11.4</td>
</tr>
<tr>
<td>Tuna</td>
<td>1,255,818</td>
<td>10.2</td>
<td>8,386,227</td>
<td>10.3</td>
</tr>
<tr>
<td>Shrimp</td>
<td>8,252,764</td>
<td>6.9</td>
<td>5,321,652</td>
<td>6.8</td>
</tr>
<tr>
<td>Oysters</td>
<td>447,297</td>
<td>3.9</td>
<td>2,367,949</td>
<td>2.9</td>
</tr>
<tr>
<td>Clams</td>
<td>525,286</td>
<td>4.3</td>
<td>2,744,956</td>
<td>3.4</td>
</tr>
<tr>
<td>Other Fish</td>
<td>298,644</td>
<td>2.</td>
<td>2,334,776</td>
<td>4.8</td>
</tr>
</tbody>
</table>

### Clams

The clam is a bivalve similar to the oyster but occurring singly and unattached. It is free moving and burrows in the earth. Of the number of species only three are of importance as a source of canned food, and these are salt-water forms, two occurring on the Atlantic and one on the Pacific Coast.

The canning of clams is generally thought of as a small industry but, as a matter of fact, has considerably greater value than others about which much more is known. The first clam cannery was established by Burnham and Morrill, at Pine Point, Maine, about 1870.
The soft clam, *Mya arenaria*, is found chiefly from Cape Cod northward; the quahaug or hard clam, *Venus mercenaria*, is found from Massachusetts southward on the East Coast and in the Gulf of Mexico; and the razor clam, *Mactra pataula*, in the Pacific waters on the coast of Oregon, Washington, and far north in Alaska.

Soft clams are the most important of the three commercial species and have various local names as soft-shelled clam, common clam, and squirt clam. This is a cold water species taken along the New England coast and occurring on sandy, gravelly, and more or less muddy beaches and tide lands that are covered at high tide but exposed at low when they burrow from one to two feet in the ground. The shells are from 2 to 3.5 inches in length, fairly smooth, and only moderately thick. The clams found on clean, sandy beaches are much smoother and lighter in color than those taken from mud flats. They are supplied with a long neck or siphon which is dark in color.

These clams are gathered by spading with a fork or digging with a heavy-pronged hoe, filled into baskets or buckets, and carried to the shore to be trucked to the factory, or filled into flat-bottomed boats and floated when the tide comes in. The method of gathering is slow and laborious, due in part to the limited time when the tide is out, which precludes taking any considerable quantity in a day. The encroachment of cities and villages and contamination of the waters by industrial wastes are also reducing the areas suitable for supplies.

**Factory Operations**

The first operation at a factory is to wash the clams well under strong sprays of water as that is the most practical method to remove the sand and mud. Simply floating them through a current of water is not sufficient to do a good job. It is immaterial whether the water be fresh or salt, but if clean salt-water be available, it is generally used more freely than fresh. The washed clams are picked over, any injured or dead ones discarded, and the good ones placed in baskets in a steamer. This may be a reasonably tight box or a retort, though steam under pressure is not necessary. The time of open steaming varies from 10 to 20 minutes, but if in the retort from no pressure to five pounds, there being no rule in the matter other than if the clams be used for bouillon as well as for meats, the steaming is heavier. The better plan is to turn on the steam for about two minutes, which is sufficient to kill the clams and cause the shells to open and to discard the juice which has accumulated up to that time since this juice consists of water held inside the shell and water which has condensed from the steam on the shells, and contains more or less objectionable matter. The juice collected from subsequent steaming contains a considerable quantity of extractives and is generally saved to be used upon the meats or for making bouillon or broth, but requires to be filtered. A primitive form of steamer was a barrel with a hole near the bottom for the insertion of a steam pipe, and a heavy canvas cover hooped snugly over the open end.

After steaming, the clams are wheeled on trucks into a room to cool and are then distributed to tables where they are snapped or shucked the same as oysters. The meats are loosened from the shell and the dark membrane cut off as one operation, then rinsed and the neck snipped off with a pair of scissors, and a final rinsing given before going to the filling table.
The cans are filled by weight so that the meats equal or exceed that required in the "cut-out." The meats lose from 5 to 15 per cent in the cooking in the cans, depending upon the amount of cooking given in the preliminary steps so that an allowance must be made accordingly. Experiments indicate that the present "cut-out" requirements are reasonable and easily attained by good packing so there is no valid excuse for short drained weight.

In packing the highest grade product, the filtered liquor is used on the meat, and supplemented by sufficient brine to cover. The majority of packers use a two per cent brine for covering in order to save the liquor, which is then diluted with brine to as high as 50 per cent and sold as juice, nectar, or bouillon.

The cans are exhausted, sealed, and given a cook at 240° F. for 20 minutes for the No. 1 tall can and 25 minutes for the No. 2 can.

Clams are prone to darken in the can due in part to the formation of iron sulphide and in part to undetermined factors. J. B. Reed* of the Bureau of Chemistry, tried the Canadian method for preventing blackening of lobster by using an acid brine. Vinegar added to brine to make an acidity equal to 0.1 per cent was sufficient to prevent the trouble without being objectionable to the taste. The trouble is greatly reduced though not wholly eliminated by the use of C-enamel cans.

Hard Clams

The clam known variously as hard clam, hard-shelled clam, little-neck clam, or cherry clam, is smaller, thicker, and with a harder shell than the common clam. Being partial to warm waters, it is much more abundant in Florida waters than in the North so that most of the canning has been transferred to the Gulf. The fresh market absorbs nearly all of the northern catch. In the North, the clams occur on the beaches below low tide so do not burrow deep in the earth nor are they exposed. They are taken by tonging and dredging. As a step in cleaning, they are placed in floats, sprinkled with corn meal to stimulate eating and to free themselves of natural sea food.

The southern clam is found in greatest abundance on a clean sandy reef about forty miles long and from four to five miles wide lying off the southwest coast of Florida. The clams are abundant, larger, and the shells somewhat thicker and heavier than those obtained in the North, besides some other minor differences. This large bed is particularly valuable as it is far removed from any city sewage contamination or industrial waste. Only two fishing villages, Marco and Caxambas, are within miles. Canning was begun at the former place in 1909, and at the latter more recently. The capacity of the two plants is about 175,000 cases annually.

The clams are taken with a dredge in the same way as oysters, and usually arrive at the factory in the morning, permitting the cargo to be packed during the day so that there is no carry-over.

The unloading is done on a chain and lug elevator which delivers the bivalves to a washing machine of the rotary type set in a tank. Tumbling the clams through the water and rinsing with strong sprays free them of all dirt. The discharge from the washer may be directly into the steaming

---

cars or they may pass over a chute, and the smaller clams, those less than 3.5 inches long, taken out as little-necks, while the others remain as plain clams. A little better grading results by making the separation at this point though it is commonly done as part of the work of snapping. The range in size of the clams is from 2.5 to 5 inches in length, some weighing as much as 2 pounds, but the average is about 1 pound.

The equipment and procedure followed for handling the clam is similar to that for the oyster with the difference that care is taken to collect the liquor which results from the steaming in retorts which are provided with drains leading to a common tank after which the liquor is pumped through a filter and made ready for its final preparation.

Since the flavor is such a valuable quality in the clam, it is customary to steam the hard-shell rather severely in order to get as much liquor as possible. Some of the meat may also be kettle-cooked and pressed to get the maximum yield.

The juice as it comes from the retort and strained is canned as clam juice, plain; if it be evaporated to some extent, it becomes clam juice, concentrate or clam nectar. Both are packed in cans of various sizes but chiefly in No. 1 and No. 2 and also bottled.

The clams are snapped or shucked and the meat collected in baskets. Whether they are graded into two sizes, those from shells of 3.5 inches or less and those above that figure depends upon the market. The grading is only approximate and can be done as a preliminary operation or by those separating the meats. The basis for payment for snapping is by the bushel.

The meats are washed in a rotary washer and discharged upon a slow moving belt from which they are taken up and filled into cans by weight to provide the “cut-out” demanded.

The meats from small clams, those not exceeding 3.25 inches in length, are marketed as “Little Neck Clams”; that from the larger clams is labeled “Steamed Clams.” The packing is chiefly in No. 1 and No. 2 cans.

Other clam meat is run through a meat chopper and becomes “Minced Clams.”

Clam meat is generally slightly dark or with yellowish tint in color, not very tender nor attractive in appearance, but has a flavor desirable in chowders and other dishes.

The cook is the same as for soft clams.

Razor Clam

The razor clam is distinct from its eastern relatives, is long and narrow, decidedly flattish, with a shell that is too small to completely enclose the soft parts. The length at full growth is about 5 inches, so that a half shell has some resemblance to the old style razor. They occur on the hard sandy beaches near the low tide line so can be taken for only a short time between tides each day. They burrow downward in the sand for a distance of two to three feet, a spading fork being used to dislodge them. The largest quantities are obtained in April and May and in September and October.

The use of this clam for canning dates only from 1894 when G. P. Halferty developed a method of preparing them. The clams are first washed under sprays to remove any sand, as neglect of this point may result in its
getting into the meats with unpleasant consequences. The clams are next fed into a combination washer and scalder, the clams falling on rocking or vibrating screens in hot water. The motion of the screen not only advances the clams through the bath but also separates the meats from the shells, delivering each separately. The meats are promptly sprayed with cold water, and a good deal of stress is placed upon this as affecting the tenderness of the meat. If allowed to cool slowly, they become tough.

The meats are delivered to the dressing tables in ordinary dishpans or other large flat pans. Each clam is taken out and split from end to end on one side thus laying it wide open. The dark mass at one end is cut out and the meats given another washing in a rocker washer and another set of trimmers complete the work by cutting off the siphon, the tough side walls which are attached to the shell, and open the stomach. Altogether, there is considerable work in preparing the razor clam by comparison with the others. The meats are run through an Enterprise style of grinder and emerge as minced clam.

The meats are filled into cans by measure, the amount upon draining giving the weight demanded in the "cut-out." The difference in fill is made up with clam nectar. They are exhausted to 140°F. or above, and cooked in a retort at 220°F. for an hour and a half for the No. 1 tall can and those of like capacity or a higher temperature may be used and a corresponding shortening in the time. There is less darkening by using the lower temperature for a longer time than if a higher temperature, as 240°F., be used for a shorter time. The cans are thoroughly cooled in the retort as soon as the cooking is completed, as experience has demonstrated that toughening of the meats occurs if the cooling proceed slowly in the air.

One bushel of razor clams will fill about 20 No. 1 salmon cans.

Clam Chowder

The original clam chowder seems to have been a rich soup containing plenty of clams and pork, the latter being fried lightly before being added to the mixture. This has gradually changed until it has become a vegetable soup with clams and pork added as seasoning.

The following formula for clam chowder more nearly approached the earlier type, especially if the diced pork be fried a light brown. Quahaus or hard-shell clams, 5,000; bacon, 50 pounds; potatoes, 50 pounds; tomatoes, 50 pounds; onions, 15 pounds; salt, 2 pounds; ground white pepper, 1 pound; parsley, chopped fine, 8 ounces; thyme, 4 ounces; sweet marjoram, 2 ounces; and water, 30 gallons.

The clams are washed, then either steamed or raw shucked, in cold water; drained and chopped (not too fine). The bacon and potatoes are diced, preferably about 1/8 inch in size. The water, clams, bacon, onions, potatoes and tomatoes are placed in a kettle, brought to a boil and cooked for 10 minutes; then seasoned; stirred to obtain an even mixture and filled into cans. No. 1 cans are heated at 250°F. for 40 minutes and No. 2 cans for 60 minutes.

Label Weights

The weights recommended for declaration on the label are as follows:

Clams: 8Z Short, 7\(\frac{3}{4}\) ozs.; 8Z Tall, 8\(\frac{1}{2}\) ozs.; Picnic, No. 1 East, 10\(\frac{1}{2}\) ozs.; No. 300, 15 ozs.; No. 1 Tall, 1 lb.; No. 303, 1 lb.; No. 2, 1 lb. 4 ozs.;
APPERTIZING

No. 2½, 1 lb. 13 ozs.; No. 3, 2 lbs. 2 ozs.; No. 5, 3 lbs. 9 ozs.; and No. 10, 6 lbs. 10 ozs.

Clams, minced: No. ½, 6½ ozs.

Clam juice (fluid measure): 8Z Short, 7 ozs.; 8Z Tall, 7¾ ozs.; Picnic, No. 1 East, 9½ ozs.; No. 300, 13½ ozs.; No. 1 Tall, 15 ozs.; No. 303, 15 ozs.; No. 2, 1 pt. 2 ozs.; No. 2½, 1 pt. 10 ozs.; No. 3, 1 pt. 15 ozs.; No. 5, 1 qt. 1 pt. 4 ozs.; and No. 10, 3 qts.

Clam chowder: The same weights as for clams.

Composition of Clams*

<table>
<thead>
<tr>
<th>Type of Clams</th>
<th>Refuse</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrates</th>
<th>Ash</th>
<th>Total Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Clams in shell</td>
<td>41.9%</td>
<td>49.9%</td>
<td>5.0%</td>
<td>0.6%</td>
<td>1.1%</td>
<td>1.5%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Soft Clams canned</td>
<td>84.5</td>
<td>9.0</td>
<td>1.3</td>
<td>2.9</td>
<td>2.3</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>Quahogs in shell</td>
<td>67.5</td>
<td>28.0</td>
<td>2.1</td>
<td>.1</td>
<td>1.4</td>
<td>0.9</td>
<td>4.3</td>
</tr>
<tr>
<td>Quahogs canned</td>
<td>82.9</td>
<td>10.5</td>
<td>.8</td>
<td>3.0</td>
<td>2.8</td>
<td>17.1</td>
<td></td>
</tr>
</tbody>
</table>


Food Inspection Decision No. 144 states that in canned food products the can serves not only as the container but also as an index of the quantity of food therein. It should be as full of food as is practicable for packing and processing without injuring the quality or appearance of the contents, and such products as require the addition of brine, water, etc., for proper preparation should contain only sufficient liquid to fill the interstices and cover the product.

The Board has received many inquiries from canners of clams regarding the weights of clams which cans should contain in order to comply with this requirement of the above decision. The subject has, therefore, been investigated by the Bureau of Chemistry. As a result of this investigation, it is the opinion of the Board that cans which contain the weights of drained clam meat shown below will satisfactorily fulfill the requirements of Food Inspection Decision No. 144. These weights are "cut-out" weights, i.e., the weight of meat left in the can after all free liquor has been drained off.

<table>
<thead>
<tr>
<th>Type of Can</th>
<th>Diam., Inches</th>
<th>Height, Inches</th>
<th>Cut-out Weight of Clams</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 Regular Oyster</td>
<td>2½</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>No. 1 Maine Style</td>
<td>3</td>
<td>4½</td>
<td>8</td>
</tr>
<tr>
<td>No. 2 Short or Picnic</td>
<td>3¾</td>
<td>4</td>
<td>8½</td>
</tr>
<tr>
<td>No. 2 Regular</td>
<td>3¾</td>
<td>4½</td>
<td>10</td>
</tr>
</tbody>
</table>

When cans of other sizes are used, they should contain proportional weights of meat.

It should be remembered that a loss of weight almost invariably occurs when clams are processed, and due allowance should be made for this loss in weighing the clams into the can. It is believed that the experience of the packers is such that there will be no difficulty in making the proper allowance for shrinkage in processing, thus avoiding shortage from this cause. It may be said the investigations made in the Bureau indicate that the loss in weight in processing varies from about 5 to 15 per cent, the average being 10 per cent of the weight of clams placed in the cans. The weight of drained clam meat should not fall below those given above, or if a variation occur, it should be as often above as below the weights specified.

S. R. A. No. 343. Weights of Minced Razor Clams and Minced Hard-shell Clams in Cans of Various Sizes.

The Bureau has made an investigation to determine the amount of minced razor clams contained in cans of various sizes when packed to capacity without impairment in quality of the product. It has been found that properly filled cans yield at least the following drained weights:

No. ½ Flat (Salmon)—3½ by 2 inches ............................................. 3½ ounces
No. 1 Regular (Eastern Oyster)—2½ by 4 inches ............................ 5 ounces
No. 1 Tall (Salmon)—3 by 4½ inches ........................................... 8 ounces
No. 2 Regular—3¾ by 4½ inches .................................................. 9 ounces

These weights apply also to minced hard-shell clams. Cans of sizes not mentioned
should be proportionately filled. The procedure for determining the drained or "cut¬
out" weight is the same as that described in Service and Regulatory Announcements,
Chemistry 14, Item 134.

"Make a circular cut almost around the top of the can, push the cut top back into its
original position, invert, and allow the contents to drain through the circular opening
for one minute. Pour the liquid through a colander and return any weighable particles
of solids which have been carried away by the liquid. The opening in the colander
should not exceed ½ inch in diameter."

The weights here named should be regarded as minimum weights. Should future
investigations indicate that any or all of them are too low, appropriate changes in the
ruling will be made.

In making declaration under the net weight requirement of the Federal Food and
Drugs Act, the total weight of the can, liquid included, should be declared.

CODFISH HASH

Codfish hash is frequently referred to as a New England dish and, like
baked beans, was patented as a canned article. The patentee was S. Rich,
Boston, and the No. 201,834, issued November 23, 1876.

I will give one mode of procedure, which I prefer, as follows: Take four pounds of
sound cured codfish (Georges fish preferred), and thoroughly cleanse it from adhering
salt and impurities by soaking and washing in tepid water, instead of parboiling, as is
the usual process when preparing it for the table, and then reduce it to the form of
pulp by any suitable means; take five pounds of good potatoes, boil them until they
are well cooked, then remove the skins and mash them; take about half a pound of
raw onions and chop them fine; take at least half a pound of pure "tried out" beef
tallow. Now put these four ingredients together, warm them, and mix them thoroughly,
adding during the mixing not more than a quarter of a pound of saltpeter and a
quarter of an ounce of red or black pepper, mustard, or suitable condiments to flavor
the mixture and make it palatable. While this is warm, fill the tin cans or other suit¬
able packages with it, and hermetically seal them. Then boil these sealed packages for
about three hours in a solution of salt and water at a temperature above 212° F., in a
manner commonly known to packers of preserved food, and after cooling, their con¬
tents are preserved.

In this process the melting fat and the small proportion of saltpeter are essential
ingredients, and my invention is based upon compounding and melting them with the
fish and potatoes together in closed vessels; but I do not intend to limit my invention
to the exact proportions of the formula given above, nor to the use of any particular
kind of fat that may be adapted to serve my purpose successfully, and other vegetables
—such as beets or turnips—may be used with or in place of part of the potatoes.

This is an unimportant item in trade.

CRABS

Callinectes sapidus

The canning of crab meat originated with James McMenamin, Norfolk,
Virginia, in 1878. The following year he transferred the business to Hamp¬
ton at which place the operations have been continued. It is the only firm
which has been successful over a long period.

Crabs occur all along the Atlantic Coast, there being a number of vari¬
eties, but the blue one is the only species in sufficient abundance suitable
for canning. The center of this fishing is Chesapeake Bay. The season for
catching is from April to November, the majority of those used for canning being taken in the fall. The price of the fresh crab meat is so attractive that there is little incentive to can it except to take care of a surplus catch.

The crabs are either caught on a trot-line or taken with a drag-net. Only the hard-shelled crabs are used for canning. They are brought to the factory as promptly as possible, are washed and placed in metal cars which are run into a steam box. The steaming kills them promptly but it is continued for about twenty minutes in order to cause the flesh to become firm. After the crabs are cooled, they are stripped; that is, the shell, viscera, and smaller claws are removed. The meat is then picked from the larger claws and body by means of a fork or heavy short bladed knife. Removal of the meat may also be accomplished by means of compressed air or by centrifugal force, but these methods divide the meat very finely and in the long run have not proved satisfactory although labor is saved. The meat is graded into white and dark, the former being the more attractive, though the latter is said to be of better flavor.

The meat is washed in brine, drained, and packed in No. 1 flat cans. These are C-enamel lined, whereas formerly they were paper lined, as for shrimp. A little salt is added. The cans are given an eight minute exhaust but some of the packers insist that the older method of closing, steaming for a half hour, then venting, gave a better product. The cook is one hour at 240° F.

Some darkening occurs in all Atlantic and Gulf crabmeat and this irrespective of the container so that canning is practically given up and its place taken by refrigeration.

On January 7, 1936, a patent No. 2,027,270 was issued to C. R. Fellers, Amherst, Massachusetts, for a method to prevent discoloration of canned crab meat, of which the following is a part:

“In the canning of meat from the ‘blue crab,’ ‘rock crab,’ or ‘sand crab,’ the improvement which comprises subjecting the meat to treatment before initial discoloration, with an aqueous solution of a salt of the class of metals consisting of aluminum, zinc, and tin, the concentration of said solution being such as to contain 50 to 500 parts per million, computed as metal, of said salt, sealing the treated meat in container, and hermetically sterilizing the meat in the containers after sealing.”

Japanese Spider Crabs

The Japanese spider crab, Paralithodes camtschatica, is a very large species, occurring locally in small numbers but in large numbers northward in Siberian waters. It was one of the earliest products which the Japanese conserved by this method and was included in their fishing industry in 1892 at Otaru. They saw the advantage of having a floating cannery and had a vessel equipped for the work in 1916. Canned crab meat constitutes one of their chief articles of export to this country, being in excess of 400,000 cases annually.

Mr. T. W. Bower, United States Bureau of Fisheries, gives the following description of the process in The Canner, July 30, 1932:

“Fishing methods differ greatly from those used for taking crabs on the North American coasts. At present the Japanese floating canneries use nets
of cotton twine, measuring 165 feet along the cork line, 153 feet along the lead line, and 81 feet in depth. The nets are held up by glass buoys attached to the cork line by manila ropes. The buoy ropes are 30 to 50 per cent longer than the depth of the water, thus preventing the net from hanging as a vertical wall in which the crabs would not become entangled.

"Fishing is carried on at a depth of 20 to 30 fathoms from small boats that accompany the floating canneries. Each boat has a crew of eight men who operate 500 crab nets of the size described. The nets are anchored in gangs or lines of 20 nets attached to each other, the last net being marked with a buoy bearing a colored flag. Net after net is spread until more than 10 miles of the sea bottom around a floating cannery may be covered.

"After two or three days the nets are lifted and the crabs removed. Care is taken to prevent the crabs from being exposed to the sun for any length of time, as it is believed to be one of the causes of deterioration and discoloration of the meat.

Canning

"The crabs are prepared for canning by first removing the back shell and washing the exposed parts thoroughly. They are then placed in large wire baskets in boiling water for 10 to 12 minutes, after which they are immediately cooled in salt water. Rapid cooling is said to prevent the crabmeat from losing its normal color and later turning black in the can.

"After cooling, the meat is removed from the legs and body and carefully separated into four grades based upon quality. The best crabmeat is obtained from the first segment of the legs, and the body meat is considered the poorest in quality. Other grades are obtained from the smaller segments of the legs. The meat is again washed in cold water and all extraneous debris and insufficiently cooked meat removed.

"The washed product is allowed to dry on trays, each tray containing only one grade of meat. When thoroughly dry it is delivered to the 'cutters' who trim the pieces to fit the cans. From the cutters the meat is conveyed in porcelain dishes to the 'hand packers.'

"The cans used are made from either lacquered '2A charcoal tin' or lacquered 'canners' special coke tin.' The insides of the cans are relacquered with a lacquer derived from Japanese cinnabar. The most common can size is the \( \frac{3}{2} \) pound flat, the 1 pound can is also used.

"In accordance with Japanese crab-packing regulations, the meat is wrapped in parchment or paraffin paper to prevent contact with the metal of the container. First quality meat is packed on the bottom, sides and top of the can so that the reddish color is on the outside. Second and third grade meat makes up the balance of the contents. Each can is filled to satisfy a definite required weight.

"After filling, the tops are put on the cans and clinched loosely. They then pass through a steam exhaust box at a temperature of 212° F. This requires from 7 to 10 minutes, and as the cans emerge from the exhaust box the tops are sealed. The vacuum obtained in this manner varies between 7 and 10 inches.

Processing

"Processing of crabmeat is an operation requiring particular care, as it is said that cooking for too long a time or at too high a temperature is
responsible, in part, for a change in taste and appearance of the meat. Japanese experience indicates that the temperature should not be higher than 221.5° F. for 80 minutes for the ½ pound can, or 224.4° F. for 80 minutes for the 1 pound can.

"Upon removal from the retort the cans are washed in warm water and promptly placed in cold water. Large fans complete the cooling process. Prompt cooling, as already stated, helps to prevent changes in flavor and appearance of the product.

"A comparatively large cannery crew is required because modern machinery plays a very small part in the present methods of packing the spider crab. It has been estimated that a floating cannery with a daily capacity of 300 cases of ½ pound cans requires an operating crew of 162 men, many of whom are skilled workers. In addition, eight boats, each with a crew of eight fishermen, are required to supply such a plant with the necessary raw material.

"Rigid inspection of all canned crab intended for export has been responsible for the steady improvement in methods, and improved quality."

**Discoloration**

The Japanese have conducted considerable research upon the cause of darkening or blackening of crab meat in the can. In one of their earlier investigations they determined that it was due in large measure to sulfur compounds in the blood so that by killing the crustacean by bleeding the necessity for a lacquer-lined can could be avoided. A patent, No. 1,172,076, February 15, 1916, was issued to K. Usui, Hokkaido, Japan, for such a process.

More recent work has been done by Kokichi Oshima, showing that blackening is closely associated with the pH value. The reaction of strictly fresh caught and killed crabs is around 6.5, and this increases after killing and holding and reaches about 8. when the crabs are badly decomposed. The higher the pH the more pronounced the blackening. He recommends that canning of crabs be done at the earliest possible moment after catching and killing. This greatly reduces the trouble. In lieu of this he recommends buffer solutions be used as sodium hydroxide and citric acid, sodium hydroxide and tartaric acid, and sodium phosphate to bring the pH within the range of 6.5 to 7.5. The citric acid is the best.

In addition, the meat is cooked at a lower temperature, under three pounds steam pressure, for 1.5 hours.

Mr. Oshima was granted U. S. Patent No. 1,686,393, October 2, 1928, and assigned it to the Bureau of Fisheries.

He also investigated "blue meat" in the crab and concludes that it is due to copper in the blood but the research is not yet complete.

**FISH FLAKES**

Fish flakes is a designation for a mixture of meat from the cod and other fish caught with them, especially haddock. The flesh is precooked, deboned, broken apart in small bits and mixed. The product was developed by Burnham and Morrill, Portland, Maine, in 1898, and although designated by a copyrighted term, it has also come to have a generic significance.
for preparations of that style. The object is to supply a fish food which will keep under a wider range of conditions than the regular dried fish, at the same time requiring much less time and trouble in preparation for the table.

The fish are brought to the factory as fresh as possible, dressed, washed, and placed in a pickle until mildly corned. The time in corning can be varied by the strength of the brine used, varying from a few hours to a few days. The fish are then soaked to freshen them. The principle object in pickling is to give a degree of firmness to the flesh, for without this treatment it will break down in the preliminary steaming and in the can during sterilization, becoming soft and almost soupy. The corning also develops a flavor not obtainable when this step is neglected.

The corned fish are placed on trays in a single layer and steamed in a retort or steam box until the flesh is thoroughly cooked and will break apart, then delivered to the packing tables where the skin and bones are removed. The cooking is not carried to the point where the bones will separate from each other but can be removed as a nearly complete skeleton. The flesh is then broken apart and packed in enamel-lined cans but no brine is added. The cans are exhausted, and cooked for one hour at 240° F. for 8 ounce cans, or 75 minutes for 12 ounce cans.

**FISH ROE**

The canning of fish roe is a by-product in the handling of fish for the fresh market. The roe is removed when dressing the fish for icing or freezing and at times a surplus results. The most valuable roe is that from the shad and was formerly obtained in the spring when the run is on in the rivers emptying into Chesapeake Bay in the East and now in the Columbia and Sacramento Rivers in the West.

The roe is washed thoroughly to remove the blood. The Eastern packers then mince the roe and fill it into cans with sufficient brine to produce the proper consistence in the finished product. The western packers keep the roe whole or as nearly so as possible and prefer the 1/2 and 1 pound oval sardine cans for their style of packing. Brine, oil, or sauce is added to complete the fill. In both cases the cans are well exhausted before closing. Cans of less than one pound are cooked 60 minutes at 240° F. and one pound or more are given 75 minutes.

The whole roe is firmer and dryer than the minced and may be used in a greater variety of ways in the preparation for the table.

Herring roe is prepared at different points in Maryland, Virginia, and North Carolina, following the same method as for the shad.

**S. R. A. No. 321. Weights of River Herring Roe in Cans of Various Sizes.**

Investigations by the Bureau indicate that properly filled cans of river herring roe will yield at least the following drained weights of roe, the weight being determined in each instance by draining for two minutes.

- No. 2: 3 1/2 by 3 1/2 sanitary, or 3 3/4 by 4 1/4 inch hole and cap. (18 ounces) 1 pound 2 ounces.
- No. 2 Special: 3 3/4 by 3 1/2 inch sanitary. (16 ounces) 1 pound.

In making declarations under the net weight requirement of the Federal Food and Drugs Act, the total weight of the contents of the can, liquid included, should be declared.
The lobster is the most highly prized of all the crustaceans. It is the aristocrat among sea foods, either fresh or canned, and the price demanded places it in the class of luxuries. Its reputation was such that it was one of the first foods sought and canned in Maine and Canada, the start in both Eastport and Halifax being made in 1842. It was the first product to be canned on such a scale as to practically exhaust the supply in New England waters and greatly deplete those of Canada.

How abundant lobsters were in New Brunswick is indicated in a report by Perley on the sea and river fisheries of that province. He states “That at Shippagan and Caraquette, carts are sometimes driven down to the beaches at low water, and readily filled with lobsters left in the shallow pools by the recession of the tide. Every potato field near the places mentioned is stewn with lobster shells, each potato hill being furnished with two or three lobsters.” A note also in Simmonds “Curiosities of Food,” states that in 1847, 10,000 cases of lobster were packed at Portage Island. “The preservation of lobsters in this manner need only be restricted by the demand, for the supply is unlimited. The price paid for lobsters, at the establishment on Portage Island, is 2s, per 100. They are all taken in small hoop nets, chiefly by the Acadian French of the Neguac villages, who, at the price stated, could with reasonable diligence, make £1 each in the 24 hours; but they are somewhat idle and easily contented, they rarely exert themselves to earn more than 10s, per day, which they can generally obtain by eight or ten hours’ attention to their hoop nets.”

This crustacean resembles a huge crawfish armed with particularly large claws, the whole body being strong and active. It is dark colored while in the sea, but turns a bright pink upon being boiled, the flesh becoming very white and tender with a peculiar sweetish taste that makes it much sought after. Lobsters occur in rather deep water along the coast from North Carolina to Labrador, but only in fairly plentiful quantities in Canadian waters. They are caught in traps called “lobster pots” which consist of a crate made of stout laths. These are about 3½ to 4 feet long, 20 inches wide, and 16 inches high with an entrance on one side or end. They are weighted to rest on the bottom of the sea, with a buoy marker attached. One or two men take these traps out in a dory and plant them, lifting them the following day. It is slow and difficult work at best, and dangerous in bad weather. However, up to 1890, lobsters were sufficiently plentiful that one-pound cans were sold for as little as 5 cents, and it takes 3½ pounds of live ones to furnish one pound of picked meat.

The depletion of the supply was rapid and artificial propagation has not been very successful.

**Preparation**

The lobster is killed by dropping it into boiling water, and then a lively cooking kept up for 30 minutes. As an aid to making the flesh firm, about 3 per cent of salt is added to the water in which they are cooked, and 6 per cent to the water in which they are cooled.

When the lobsters are thoroughly chilled, the tail and claws are pulled off, the body opened, and the viscera removed. The claws are cracked, the
tail cut, and the meats picked out with care so as to preserve the pieces as nearly whole as possible. The pieces are rinsed and are ready for filling into the can. The tail meat is usually placed at the bottom of the can, the claw meat on top, and the smaller pieces used between. This is merely a detail in presenting a good appearance when the can is opened. The packing is done with fairly firm pressure without mashing, no water or salt being added.

C-enamel type cans are used or in lieu of these the plain can lined with parchment paper. Better still is the C-enamel can with a paper lining. Plain cans are unsatisfactory owing to the formation of black iron sulphide. It is claimed that a slight foreign flavor is sometimes observed in lobster packed in lacquered cans, so to avoid this the Canadian packers rinse the meats in a weak citric acid solution, which is also said to be effective in preventing darkening in plain cans. The acid solution is made so weak that no flavor is imparted to the flesh.

The cans are exhausted from 12 to 15 minutes to drive out the air, and the work completed by cooking for 1 hour at 240° F. The cans generally are the one-quarter and one-half pound flat.

The glass container is being used to a limited extent to avoid discoloration. The cooking period is 2 hours at 220° F. or 3 hours at boiling.

**Label Weights Recommended**

No. ¼, 3 ozs.; No. ½, 6 ozs.; No. ⅜, 9 ozs.; No. 1 Flat, 12 ozs.; and No. 1 Tall, 1 lb.

**Comment**

The first scientific investigation upon canning in Canada was a study of lobster canning by Dr. Andrew Macphail in 1896. It included both the chemical and bacteriological study of spoilage and discoloration. It is of exceptional merit and is reproduced in this work in the chapter dealing with the history of the art.

**MACKEREL**

*Scomber scombrus*

The mackerel family embraces a number of very active saltwater fish which are highly esteemed for food. They have a distinctive texture and a flavor which is pronounced in fresh or frozen stock and another but different when salt cured. These qualities are sufficient to command a premium over most other fish. In canning, however, these distinctive qualities are largely lost so that the quantity conserved in that way has been small.

The canning of mackerel had its inception at Eastport, Maine, at the same time as the canning of lobster. The two were generally packed in the same factory until in the nineties.

The method followed was to wash, scrape, cut off the head and tail, split the fish and if large to cut it to lengths to fit the can. The fish was soaked in strong brine for an hour, washed in cold water, and filled into the cans. The sterilizing was done by boiling in a bath for an hour, venting, and returning to the bath for two hours more.
Boiled mackerel was introduced in 1880, the packing being essentially the same as for sardines.

The mackerel caught on the Pacific Coast are of the same species as occur on the Atlantic and are obtained chiefly off Lower California and California as far north as Monterey Bay, with the center of fishing near San Pedro. Probably more than three-fourths of the catch is prepared at that point. The fish occur in numerous relatively small schools, run near the surface, out from shore. The fish are of medium size, from 12 to 16 inches in length with an average of about 14 inches. They are firm but not nearly as fat as in the Atlantic, which makes them much more satisfactory for canning but not for curing.

While the sardines and mackerel do not run together, the former being caught at night and the latter by day, the same boats and gear are used in fishing, or since the mackerel has become an important item the gear has been modified in some respects to more nearly meet the conditions. It naturally followed that the crews desired an outlet for both so that one could supplement the other. The sardine packers tried canning the mackerel using the same process but without success. A. P. Halfhill put up a trial pack in 1893 and repeated with some modifications the succeeding year but found so much trouble in disposing of them that he discontinued further efforts, and without success, it was no encouragement to others. Twenty years later the South Coast Co. at Long Beach put up a small pack after the style of the Eastern herring but met the same sales resistance. The World War came on causing an advance in prices of all foods and stimulated nearly all the fish packers to make trial packs but they dropped the matter as being unprofitable. In 1923, The Van Camp Sea Food Company made a special effort, using the choice fillets, but the experience of one season was enough. In 1927, a Japanese fishing firm, Toyo Fisheries, at Wilmington, made a 10,000 case pack, the same as large herring, labeled it “salmon style,” sent it to the Philippines and the Orient and found an immediate market. In 1928, the pack was boosted to 385,000 cases and the next year to 595,000. The depression cut down the pack and forced the packers to look for a home market. The cost of the raw stock being low, from $12 to $15 per ton, and packing not expensive, it permitted sales in competition with any other product and these continued to increase. By 1934 the pack reached 1,250,000 cases, and in 1935 1,750,000 cases. This is the most phenomenal growth ever made by a sea product though probably to some extent at the expense of the pink and chum salmon and the sardine.

The fish are brought to the canning plants and unloaded with the same equipment used in handling large sardines, but on account of lack of scales on the mackerel, are not run through the scaler, or if so, only for the purpose of washing them. They are then conveyed directly to the cutting tables. Here the hand cutters first cut off the head just back of the gills; the same operator may make a dextrous turn of the knife, slit the belly and remove the viscera, or the fish may be passed to another operator who cuts off the tail, slits the belly, and removes the viscera. The waste drops into a flume and is carried to the reduction plant while the dressed fish are tossed into a measuring box to be checked. As this part of the work is done on a piece basis. The fish are then dropped into a flume which carries them
to another table where they are brushed to remove the blood streak along the backbone and are cut to the proper length to fit the can. The cutting may be done on a special block built for the purpose or the fish may be fed crosswise on a conveyor which passes under disks spaced to make cuts corresponding to the height of the can used. The cut fish are discharged into the brine tank. Hand work is preferred for the cutting though the sardine machines are being modified in details and otherwise perfected for the purpose.

The fish are held in a 60 degree brine from 45 to 60 minutes to give firmness to the tissues, are sprayed as they are drawn out, and are hand packed into one-pound tall cans. The fillers use one whole cut and a piece to a can. If the two are too much, the piece is split lengthwise. The eye soon becomes trained to select the two pieces which will give very nearly the correct weight.

Some packers eliminate the brining process, and where this is done, salt is added to the can, either before the fish is put in or after. The addition is made by machine and is more uniform when added first as when added afterward some may be displaced in the exhausting. The quantity is usually about one-fourth of an ounce to a one-pound can.

The fillers place the cans directly upon the conveyor which carries them through the exhaust box, so there is no chance for standing after packing. Each can is inspected as it goes into the exhaust to see that the fish are packed neither too heavy nor too light, a check being made by weighing any which appear to be off-weight in either direction. A can which is packed too light shrinks in the exhaust box to a point where the product easily breaks to pieces after cooking in the sterilizer. If packed too heavy, there may be difficulty in sealing and also flippers result.

The cans need to be thoroughly exhausted, preferably for a long time at a rather low temperature. The time should be about 15 minutes with the object of bringing the center of the can above 130° F. A better appearance is obtained when the heating is done slowly. Upon coming out of the exhaust box, hot water is added until they overflow, which gives a full can when the cover is sealed in place.

As the cans leave the sealing machine, they are washed with hot alkali, sprayed with water and delivered in baskets for the retort. No effort is made to give them a position in the baskets.

The oval can is used on only about 10 per cent of the pack. It gives a much more attractive appearance to the fish than when jammed into the round can.

The regulation of the California State Board of Health requires that all mackerel packed within the State be cooked at 240° F., whether eight ounce sauce or No. 1 regular, for 75 minutes. No. 1 tall and oval may be cooked at 250° F. for 75 and 50 minutes, respectively.
OYESTERS

*Ostrea virginiana*

The oyster is the most abundant of the shellfish and is also the most sought after. This was equally true in the time of the aborigines and the Indian as is clearly indicated by the huge shell mounds along the Atlantic Coast from Cape Cod southward and around the Gulf of Mexico. The thick beds of shells in San Francisco Bay and at a few other points on the West Coast bear evidence that the bivalve was plentiful in those waters also, and the shell mounds fix the date within the time of human habitation.

The importance of the oyster to the New England colonists was such that they passed laws for the protection of the beds before the end of the seventeenth century, thus marking the beginning of efforts at conservation. It was the first food product to be protected in this country.

The oyster occurred in greatest abundance in Chesapeake Bay and adjacent waters and until as recent as 1900 there seemed to be an unlimited supply so that no measures were taken for their protection. Those waters became the center for the fishing for the fresh market which increased as rapidly as improvements were made in the means for distribution. In 1844, Thomas Kensett started the canning of oysters in Baltimore and during the succeeding half century 90 per cent of the packing was done in that city or in its vicinity. The demand to supply the fresh market and canning industry plus unrestricted dumping of industrial wastes polluted the water for miles and suddenly interrupted the course of a bounteous nature. The catch became so small that canning had to move to new sources of supplies, as Mississippi and Louisiana.

Science has revealed the life history of the oyster so that practical methods of propagation are available and their application has greatly increased production. The crop from oyster farming in this country amounts to about $15,000,000 annually. In 1929, oyster meats amounted to 152,000,000 pounds or one and one-quarter pounds for each person. The production in this country amounts to about 80 per cent of that for the whole world.

For some unknown reason the native oyster, *Ostrechina lurida*, practically disappeared from the Western Coast and plantings from the Atlantic seashore have met with little success as they do not maintain themselves. Since 1930 plantings of the large Japanese oyster, *Ostrechina gigas*, have been made and, while they grow well, it is evident that spat must be imported each year. By that system the yield is already sufficient to supply the Far West with the fresh bivalve and have a surplus for some canning.

**Fishing**

The oyster grows naturally on reefs in from 10 to 180 feet of water and in shallower water in well protected bays. Most of those produced in the Gulf are from shallow marsh beds which have been strewn with shells to which spawn attach themselves. The plantings in Washington are on tide lands which are exposed for a brief time each day.

The fishing season for canning is regulated according to the locality. In general the work is confined to the cooler months or from October to March. By October the flesh is in good firm condition and is poor again at the start of the spawning season in the spring.
Oysters are collected by tonging in shallow water and on planted beds but by means of dredges in the open bays. Tonging is done by one or two men standing in a flat-bottom boat. The tongs consist of a pair of strong, heavy rakes about 2 feet wide attached to handles about 12 feet long. The handles are hinged near the grappling end and by proper manipulation the shells can be worked between the teeth and lifted into the boat. The fishermen work over the bottom picking up such shells as can be gathered by the rakes. The limits of the grounds or beds are marked by stakes or buoys and the work conducted systematically so as to get the highest percentage of shells of a large size. The boat will carry from 6 to 8 barrels.

Dredging was formerly done by schooners measuring about 50 feet in length and 16-foot beam, manned by a crew of 5. These are now equipped with auxiliary power and some are being replaced by smaller power boats so that trips to the beds can be made under any conditions and with quicker delivery to the factory. The capacity of a schooner is about 275 barrels. The dredge consists of a heavy iron rake about 4 feet in width with a rope or chain purse attached. It is drawn over the grounds by the boat and raised at intervals to unload the purse. If the boat is to be out only one day, the oysters are left on deck, but if the trip should require a longer time, they are dropped into the hold. Oysters have to be protected from the sun or they will die.

Oysters are graded for size, those running from 800 to 1,000 per barrel are known as standard; from 600 to 800, select; from 450 to 600, extra select, and below 450 as counts. The counts and extra selects bring a fancy price as fresh oysters, so are canned only upon special orders. The same names follow through the factory and upon the labels.

When the oysters are brought to the factory, they are delivered directly from the boat into a car for steaming. This is a steel crate 28 inches wide, 19 inches deep, and 8 feet long mounted on wheels. Each car will hold 5 barrels of 2½ bushels each. As soon as the cars are filled, the oysters are sprayed with a hose to remove adherent dirt and mud.

The cars are run into a steam box and heated to expedite the shucking. The live oyster holds its shell tightly closed so that it requires considerable force to open it. Louis McMurray of Baltimore, was the first to apply the home method of dropping the oysters into boiling water to cause the shells to open for the removal of the meat in 1858 and others immediately followed his example. In 1863, C. Smith saw a sign “Steamed Oysters” in a restaurant window, and sensing the application to canning, obtained a patent on the process and sold it to Thomas Kensett for one dollar. Thus was inaugurated the process of steaming oysters as preliminary to shucking and making it possible for women to do the work instead of men.

The steam boxes are of a length and size to accommodate three cars. Steam is turned in to obtain a pressure of 10 pounds which is maintained from 3 to 5 minutes. The cars are then promptly removed to the air to cool. The time allowed for the steaming is sufficient to cause some shrinkage so that very little occurs in the subsequent sterilization, but not continued long enough to cause the meat to become crumbly.

Shucking the oyster is done directly from the cars, the meats being placed in small measures for weighing and the shells dropped on the floor where they are raked on a conveyor to be taken to the grinding mill or pile. The
shucking is done with a short heavy-bladed knife, is piecework with pay-
ment per pound of meat.

The oysters are washed, then transferred to the filling tables. The filling
is hand work and the cans filled to a definite weight after which brine is
added to complete the operation. The amount of meat is made slightly in
excess of that demanded in the cut-out as there is always some shrinkage.
Since this varies with the season and the condition of the oysters, it is
necessary to test the cut-out at short intervals to be certain that the quantity
is correct. The brine is usually composed of 2 pounds of salt in 10 gallons
of water.

The cans are exhausted for 5 minutes and cooked at 240° F. for 12 min-
utes for No. 1s or smaller and 15 minutes for No. 2s. Plain cans are used.

Pacific Coast Oysters

Oyster growing and canning in the Northwest is purely cultural as far
as production is concerned and the factory equipment and operations have
been developed along efficiency lines without the handicaps of precedent.

At the present time the operations are limited to Padilla Point and
vicinity near Everett, Washington, the 4,000 acres of beds being operated
and owned by a co-operative company. The site is on a broad, flat beach
covered with about 4 feet of water, except at low tide when it is exposed.

The spat or very young oyster is purchased from Japanese growers who
make a specialty of the business. This is imported in cases containing ap-
proximately 20,000 young and ten cases are required for each acre. The
material is broken apart and distributed over the ground as evenly as pos-
sible in alternate strips or squares of about one-half to an acre each. When
in squares they are in checkerboard fashion. The spat is obtained in Febru-
ary and March through weekly shipments so that in the event of storm or
other conditions not within control the loss from planting would not be
complete. The time required to produce an adult is from eighteen months to
two years so that by planting only one-half the area each year the beds may
be kept in constant production; furthermore, it leaves a greater abundance
of food for those which are growing.

The harvesting of the crop is unique. A scow is towed to the beds at
high tide and distributes, where wanted, large galvanized iron baskets capa-
bile of holding 25 bushels each. At low tide the shells are gathered by raking
and are filled into the baskets. At the next high tide the scow returns and
hoists the baskets on board and is towed to the factory. This operation is
continued as long as shells remain to be collected.

The innovation in the factory is nearly as distinctive, characterized by
the employment of labor-saving devices of the most sanitary type. The
oysters are unloaded from the scow into a hopper from which they are con-
veyed into a heavy rotary washer which is supplied with a spray working
under a head of 120 pounds pressure. The rolling motion, exposing every
part of the oyster to the washing, frees the shells of all traces of adherent
dirt, bits of broken shell, and other debris. It is the difference between a
real washing and a perfunctory wetting.

The discharge from the washer is upon a conveyor which carries the
shells through a continuous steamer, in which they are steamed at about
210° F. for 10 minutes. Again the shells are discharged upon a wire belt
which carries them over the shucking table. The shells are diverted to either side into bins of cold salt-water. This not only arrests the action of the heat but also avoids the formation of a thin layer of loose gritty material on the surface of the shell.

The shells are opened, the meats dropped into a small pan, and the refuse sent on its way to the crusher. The pans are small so that they have to be emptied at frequent intervals and thus prevent any holding of the meats. The pans are checked as a basis for payment in piece work.

The meats are thoroughly washed and as they emerge from the washer are conveyed on an inspection belt from which they are picked in three sizes as judged by the eye: small, medium, and large. The filling into the cans may be by hand or by a special filler designed for the purpose. The special filler consists of a set of cups of the proper size to fill the cans. The oysters are raked into the cups, and a mechanism slides the cans under the cups, discharges the meats into the cans, and then moves them away. Brine is added to make the proper fill, followed by the usual exhausting and cooking or mechanical exhausting may be used and the cook increased to compensate for the lower temperature on entering the retort.

**Weights**

The weights recommended for declaration on the label are: 3-oz. can (211x212), 7 ozs.; 4-oz. can (211x306), 9 ozs.; 5-oz. can, No. 1 East (211x400), 10½ ozs.; 6-oz. can (211x315), 1 lb. 1 oz.; 10-oz. can, No. 2 (307x409 and 307x408), 1 lb. 4 ozs.; and 12-oz. can (307x414), 1 lb. 5 ozs.

**Comments**

For a long time the term “Cove Oysters” was used upon the label and is seen occasionally at the present. The origin and significance of the terms is best explained by Hugh S. Orem.*

“Sometime between the years 1865-70, a canner, somewhat bolder or more progressive than his competitors, adopted as a prefix to oysters cooked in a hermetically sealed can the word ‘cove.’ Many inquiries have been sent to Baltimore asking the derivation of this term during the fifty years it has been in use. It is almost generally conceded that the thousands of inlets or coves which indent the shores of the Chesapeake Bay suggested the term ‘Cove Oysters’ to the canner who first used it, the claim being set up that he greatly desired to accentuate the marine atmosphere which surrounded his product, and accordingly adopted the term. If the facts were otherwise, this legend would remain forever undisturbed. The story is far more prosaic and commonplace. In those years, ‘Cove’ street, the identity of which is now entirely lost, was more an alley than a street, and ran east and west from the northernmost point of Baltimore’s harbor, for the distance of three short blocks. Two ‘oyster shops,’ as they were then called, were located in one of these blocks, almost directly opposite. One was a shipper of oysters in the fresh or raw state, the other a canner of hermetically sealed oysters. The canner used a label upon which was printed ‘Fresh Chesapeake Oysters’ to which the ‘raw’ man demurred. Hence to differentiate between raw and cooked oysters, the term ‘Cove

---

Oysters' was decided upon. The name of the street supplied the title and not any cove or other place in the Chesapeake Bay. Thus a legend before this day has been dispelled."

Oyster Juice

Oyster juice or oyster liquor results from the steaming of the oysters just as for clams, but owing to the mud usually attached to the shell and the heavy dilution from the condensed steam, it has not been retained. Two patents, Nos. 1,371,541, March 15, 1921, and 1,444,094, February 6, 1923, have been issued to A. Babendreer, Biloxi, Mississippi, for the recovery of the juice. The oysters are given a particularly heavy washing, then steamed in a special retort having arrangements for collecting the juice. A hot air circulating device prevents the usual amount of condensation of steam so the juice which is collected is richer in flavor.

S. R. A. No. 3. Weights of Oyster Meat Required in Cans of Various Sizes.

This notice is issued to inform the trade that pending further investigation the weights agreed upon by the canners at their meeting in Washington in October, 1912, will be regarded by the Board as satisfactorily fulfilling the requirements of Food Inspection Decision, 144. It is expected, however, that the "cut-out" weight in all cans shall conform with this agreement, and where a variation occurs it shall be as often above as below the agreed weight.

The weights which have been agreed upon are given below.

<table>
<thead>
<tr>
<th>Size of Can</th>
<th>Weight of Drained Oysters &quot;cut-out&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter, Inches</td>
<td>Height, Inches</td>
</tr>
<tr>
<td>2 1/4</td>
<td>2 3/4</td>
</tr>
<tr>
<td>2 1/2</td>
<td>3 3/8</td>
</tr>
<tr>
<td>2 1/8</td>
<td>4</td>
</tr>
<tr>
<td>3 3/8</td>
<td>3 1/2</td>
</tr>
<tr>
<td>3 3/8</td>
<td>4 1/2</td>
</tr>
</tbody>
</table>


In the opinion of this Bureau, the quantity of the contents of a package of canned (cove) oysters or canned clams, as usually packed and processed, should be declared on the basis of the "cut-out" weight of the drained meat. This also applies to canned shrimp.

In this connection, attention is called to letters Nos. 2 and 3, in the Bureau of Chemistry Service and Regulatory Announcements for January, 1914, which state the weights of drained meat which, in the opinion of the Bureau, satisfactorily fulfill the requirements of Food Inspection Decision 144 in the case of canned oysters and clams.


Because the liquid packing medium in canned clams and canned oysters has a certain food value and is ordinarily utilized as food, no objection will be made to marking the net weight of these products in terms of total weight, liquid included. When such markings are made, declaration of drained or "cut-out" weight will not be required, but in all cases these weights should equal or exceed those specified in opinions 2 and 3, pages 1 and 2, Service and Regulatory Announcements, Chemistry 1.

Opinion 88, page 688, Service and Regulatory Announcements, Chemistry 9, is modified accordingly.

Inquiry has been made regarding the duration of the time of draining to which canned oysters and clams should be subjected before determining the “cut-out” weights as specified in letters 2 and 3 of S. R. A. Chemistry 1.

The procedure adopted by the Bureau for draining in order to determine the “cut-out” or drained weight is as follows:

Make a circular cut almost around the top of the can, push the cut top back into its original position, invert, and allow the contents to drain through the circular opening for one minute. Pour the liquid through a colander, and return to the can any weighable particles of solids which have been carried away by the liquid. The openings in the colander should not exceed 1/16 inch in diameter.

SALMON

Oncorhynchus

The earliest record of the canning of salmon is that it was done in Aberdeen, Scotland, in 1824, but unfortunately almost nothing is known concerning the methods employed. The industry remained undeveloped because the supply of fish was rarely in excess of the demand for the fresh market and that which was needed for the other methods of curing. Moreover, what is very probable is that this early attempt may not have resulted in an especially good product.

The American canning of salmon had its inception March 4, 1864, on the Sacramento River at a point opposite what is now J Street in Sacramento, but which at that time was known as Washington. The circumstances which led up to this event were that William Hume left his home on the Kennebeck River in Maine in 1852 to find gold in California. Instead of going into the mines, he became a fisherman on the river. In 1857 he returned to his home and then came back, accompanied by his brothers John and George, and they too became fishermen. In 1863 George returned to his home on account of illness but fortunately made a recovery. His tales of fishing interested a former friend who had gone into tinsmithing and it was proposed that they go into the canning of the fish. Their drawback was a lack of capital, but what they lacked in this particular they made up in faith and expectations. Mr. Hume returned, obtained some backing from his brother, and sent for his friend, A. S. Hapgood. The latter had a meager supply of hand tools which he brought with him. George Hume secured an old scow that had been used as a rough houseboat and converted it into a can-making shop, canning factory, and storehouse. They succeeded in putting up 2,016 cases of fish that season, but on account of poor workmanship in making the cans coupled with no means for testing them, and lack of experience in processing, nearly half the pack was lost. To add to their troubles, they had a most difficult time to dispose of the remainder. At length they were able to realize something for their work, and this was reinvested in tinplate so that the next year they were more successful. In 1866 they transferred their operations to the Columbia River and prospered to such an extent that in 1869 they packed 6,000 cases, and then stopped for fear of overstocking the market.*

Such, in brief, is the origin of the vast salmon canning fishery on the Pacific Coast which extends from Oregon northward up the Alaskan Coast to Behring Sea and down the Asiatic side to Japan.

Salmon packing in California was of very short duration as the runs of fish were not large nor regular enough to furnish an adequate supply for a cannery. The principal fishing was on the Columbia River for a few years and then a factory was built in British Columbia in 1874, and one in Alaska in 1882. The movement was farther north every few years until the Behring Straits were reached, and then a pause after which a factory was erected in Siberian waters in 1910 and finally by the Japanese in Asiatic waters in 1914. The Asiatic waters yield about 2,000,000 cases annually not considering that packed by Soviet Russia as that is not reported. Factories preceded the settlement of the country and all the supplies with fishing and cannery crews had to be transported annually in ships for the summer fishing. The investments were large and the business organized to reap the largest possible profit within a short time, and that regardless of the need for fish or the effects upon the future of the industry. The waters were rapidly depleted and restrictive fishing had to be adopted to conserve this great natural resource. It is now recognized that only through scientific research can permanent supplies be assured.

The enormous amount of fish taken from these waters has been compiled by The Pacific Fisherman Yearbook, 1935, as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Pack of Salmon - Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1864</td>
<td>2,000</td>
</tr>
<tr>
<td>1865</td>
<td>2,000</td>
</tr>
<tr>
<td>1866</td>
<td>4,000</td>
</tr>
<tr>
<td>1867</td>
<td>18,000</td>
</tr>
<tr>
<td>1868</td>
<td>28,000</td>
</tr>
<tr>
<td>1869</td>
<td>100,000</td>
</tr>
<tr>
<td>1870</td>
<td>150,000</td>
</tr>
<tr>
<td>1871</td>
<td>200,000</td>
</tr>
<tr>
<td>1872</td>
<td>250,000</td>
</tr>
<tr>
<td>1873</td>
<td>250,000</td>
</tr>
<tr>
<td>1874</td>
<td>352,000</td>
</tr>
<tr>
<td>1875</td>
<td>378,000</td>
</tr>
<tr>
<td>1876</td>
<td>467,237</td>
</tr>
<tr>
<td>1877</td>
<td>481,900</td>
</tr>
<tr>
<td>1878</td>
<td>629,191</td>
</tr>
<tr>
<td>1879</td>
<td>577,349</td>
</tr>
<tr>
<td>1880</td>
<td>687,010</td>
</tr>
<tr>
<td>1881</td>
<td>930,573</td>
</tr>
<tr>
<td>1882</td>
<td>1,030,592</td>
</tr>
<tr>
<td>1883</td>
<td>981,831</td>
</tr>
<tr>
<td>1884</td>
<td>907,918</td>
</tr>
<tr>
<td>1885</td>
<td>857,042</td>
</tr>
<tr>
<td>1886</td>
<td>848,976</td>
</tr>
<tr>
<td>1887</td>
<td>899,256</td>
</tr>
<tr>
<td>1888</td>
<td>1,217,792</td>
</tr>
<tr>
<td>1889</td>
<td>1,614,066</td>
</tr>
<tr>
<td>1890</td>
<td>1,600,696</td>
</tr>
<tr>
<td>1891</td>
<td>1,578,746</td>
</tr>
<tr>
<td>1892</td>
<td>1,354,083</td>
</tr>
<tr>
<td>1893</td>
<td>1,876,915</td>
</tr>
<tr>
<td>1894</td>
<td>1,887,150</td>
</tr>
<tr>
<td>1895</td>
<td>2,169,848</td>
</tr>
<tr>
<td>1896</td>
<td>2,408,812</td>
</tr>
<tr>
<td>1897</td>
<td>3,124,812</td>
</tr>
<tr>
<td>1898</td>
<td>2,484,722</td>
</tr>
<tr>
<td>1899</td>
<td>2,357,825</td>
</tr>
<tr>
<td>1900</td>
<td>3,091,542</td>
</tr>
<tr>
<td>1901</td>
<td>5,186,407</td>
</tr>
<tr>
<td>1902</td>
<td>4,194,558</td>
</tr>
<tr>
<td>1903</td>
<td>3,607,073</td>
</tr>
<tr>
<td>1904</td>
<td>3,276,882</td>
</tr>
<tr>
<td>1905</td>
<td>4,607,087</td>
</tr>
<tr>
<td>1906</td>
<td>3,817,776</td>
</tr>
<tr>
<td>1907</td>
<td>3,522,506</td>
</tr>
<tr>
<td>1908</td>
<td>3,962,317</td>
</tr>
<tr>
<td>1909</td>
<td>3,391,186</td>
</tr>
<tr>
<td>1910</td>
<td>4,326,453</td>
</tr>
<tr>
<td>1911</td>
<td>6,147,486</td>
</tr>
<tr>
<td>1912</td>
<td>6,011,955</td>
</tr>
<tr>
<td>1913</td>
<td>8,242,847</td>
</tr>
<tr>
<td>1914</td>
<td>8,684,732</td>
</tr>
<tr>
<td>1915</td>
<td>7,998,592</td>
</tr>
<tr>
<td>1916</td>
<td>7,829,212</td>
</tr>
<tr>
<td>1917</td>
<td>10,692,047</td>
</tr>
<tr>
<td>1918</td>
<td>10,100,127</td>
</tr>
<tr>
<td>1919</td>
<td>8,840,514</td>
</tr>
<tr>
<td>1920</td>
<td>6,910,092</td>
</tr>
<tr>
<td>1921</td>
<td>4,939,153</td>
</tr>
<tr>
<td>1922</td>
<td>7,240,185</td>
</tr>
<tr>
<td>1923</td>
<td>8,457,103</td>
</tr>
<tr>
<td>1924</td>
<td>8,799,753</td>
</tr>
<tr>
<td>1925</td>
<td>8,408,282</td>
</tr>
<tr>
<td>1926</td>
<td>10,529,294</td>
</tr>
<tr>
<td>1927</td>
<td>7,361,004</td>
</tr>
<tr>
<td>1928</td>
<td>10,639,914</td>
</tr>
<tr>
<td>1929</td>
<td>10,049,631</td>
</tr>
<tr>
<td>1930</td>
<td>10,396,428</td>
</tr>
<tr>
<td>1931</td>
<td>9,059,988</td>
</tr>
<tr>
<td>1932</td>
<td>8,483,206</td>
</tr>
<tr>
<td>1933</td>
<td>9,069,915</td>
</tr>
<tr>
<td>1934</td>
<td>12,226,277</td>
</tr>
<tr>
<td>1935</td>
<td>9,952,088</td>
</tr>
</tbody>
</table>

The importance of the industry at the present time is shown by the fact that between $75,000,000 and $100,000,000 are invested in properties and operation and that this is divided between 100 to 110 firms, indicative of the large capital required.

The total Pacific pack amounts to about 460,000,000 1-pound cans of which more than 70 per cent are from United States waters. The total value of the latter is about $40,000,000.
Species

There are five important species of salmon occurring in the waters of the Pacific.

**Oncorhynchus nerka.** Sockeye, Alaska Red, or Blueback salmon is the most valuable and sought after of the five species. It is of medium size and weighs on an average 6 pounds. When it comes from the sea it has a brilliant bluish green back and brilliant silver sides and belly. The flesh is decidedly red and remains red in color after it has been sterilized in the can. It is of firm texture and rich in oil. At the time the fish is ready to spawn the color has changed to bright red with the exception of the tips of the nose and the tail. This species predominates in the waters of Behring Sea and is also found in large quantities in the waters around Central Alaska and Puget Sound. In most of the Alaskan waters the large runs of this fish occur in intervals of a five-year cycle. In other words, it is five years old at the time it is caught. They usually spend two years in the fresh water lakes in which they are spawned and three years in the sea before returning to spawn. This same fish in Puget Sound has a four-year cycle and it is from these first studied that the deduction was applied to all.

**Oncorhynchus tschawytscha.** King, Chinook, QuinNat, or Spring Salmon is the largest of the five species, averaging about 22 pounds though many have been caught exceeding 70 pounds. The fish is beautifully marked, dark bluish along the back and head, a silvery belly, and with small black spots on the back and fins. At the time of spawning, it changes to dark red in color. The flesh is of firm texture, varies from white to deep red in different fish, is rich in oil, and has a very fine flavor. It is taken chiefly in the Columbia River but occurs in small quantities along the entire Alaskan coast. Owing to its size and appearance, it is used almost exclusively in the fresh and frozen fish trade.

**Oncorhynchus kisutch.** Coho, Silver, or Medium Red Salmon is a very beautiful fish, dark greenish along the back with brilliant silver sides and belly and averages about 8 pounds in weight. It gets its name “Silver” from its bright silvery appearance. The fish also turns red at the time it is ready to spawn. It has firm flesh, is paler than the Red salmon, rich in oil, and of excellent flavor. The fish is universally distributed from the Oregon coast to Behring Sea but nowhere runs in large numbers.
Oncorhynchus gorbuscha. Pink or Humpback salmon is the smallest of the species, weighing on an average about 4 pounds. The color is bluish above and silvery below, the back and tail fins spotted with small black spots. The flesh is paler and softer than the aforementioned species but is possessed of good flavor. It is the most prolific of the salmon and furnishes a larger percentage of the pack than any other. It occurs in all the waters from Puget Sound to Behring Sea but in greater abundance in southeastern and central Alaska.

Oncorhynchus keta. Chum or Dog salmon is about the same size and weight as the Sockeye, averaging about 8 pounds. It is bluish green on the back with brilliant silver sides and at the time of spawning becomes dark and rather mottled in color, brick-dust red, brown and yellow predominating. When the fish is caught fresh from the sea, the flesh is reddish in color, but the color is practically all lost during sterilization and appears white or yellowish white in the can. The fish is well distributed along the entire Alaskan coast and in Puget Sound.

Formerly the fishermen included the Steelhead trout, Salmo gairdneri, with the salmon. It is not a salmon and little of it is canned so that it need not be considered.

The relative importance of these species in the different sections is best understood by taking the percentage in a ten-year period.

<table>
<thead>
<tr>
<th></th>
<th>Columbia River</th>
<th>Puget Sound</th>
<th>Alaska</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook or King</td>
<td>76.0%</td>
<td>3.0%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Sockeye or Blue Back</td>
<td>2.7</td>
<td>41.4</td>
<td>62.0</td>
</tr>
<tr>
<td>Silverside or Coho</td>
<td>10.9</td>
<td>18.1</td>
<td>.5</td>
</tr>
<tr>
<td>Humpback or Pink</td>
<td></td>
<td>28.0</td>
<td>23.4</td>
</tr>
<tr>
<td>Dog or Chum</td>
<td>8.0</td>
<td>9.5</td>
<td>8.1</td>
</tr>
<tr>
<td>Steelhead Trout</td>
<td>2.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

History

Salmon fishing in the Northwest on the Columbia and Frazer Rivers had its origin long before the arrival of the white man. It was of great importance to the Indian, who believed it to be the gift of his God, and the abundance of the fish expressed a direct measure of His favor. The time of the run was understood and made the occasion of religious observances. Probably no other manifestation of nature so greatly impressed him or was held in higher regard. He came long distances to engage in the ceremony and participate in the fishing. The fish were caught and dried and became the principal article of exchange with tribes in Idaho and other interior points.

When the paleface came upon the scene, it was without any feeling of obligation for past favors but with an eye to the profits which might be exacted from the merchandising of this excellent food to the world. What appeared to be an unlimited supply of fish from the ocean showed evidence of serious depletion in less than fifty years so that it became imperative to learn the biological cycle of this natural resource and enforce strict conservation methods accordingly. The whole history of the salmon industry, both for the protection of the supply and the development of factory operations, is one of rapid evolution. It is necessary to have this background in order to have a proper appreciation of one of the most highly specialized lines of food preparation.
Of first importance at the present time are the conservation measures necessary to insure a future supply. All fishing in the Territory of Alaska is controlled by the United States Bureau of Fisheries of the Department of Commerce. The Bureau maintains many fish wardens and patrolmen in all these waters whose duties are to see that the regulations under the law are carried out in every particular. A large amount of credit is due to the Bureau for having made intensive studies of the different species of salmon and learned the habits along biologic lines so as to have scientific data upon which to make regulations and to enforce them in such a way as to insure that sufficient fish escape the nets and other catching devices to maintain the runs on a commercially economic basis.

One of the regulations prohibits fishing in any of the rivers in Alaska, but that all fish must be taken in the ocean or in the bays. This has a double purpose, to protect the run and also the quality of the fish which are caught. In making its regulations, the Bureau prescribes the time for the open and closed periods in which one may or may not fish, the amount which may be taken, and the kind and amount of gear which may be used. Salmon fishing is peculiar in that it is based upon catching the fish while on the way from the sea to the spawning grounds which are generally located far up the rivers or in the lakes. The fish, as they come from the sea, are at the maximum for size and in the best possible physical condition. A little later when in fresh water, they become exhausted and thin from their efforts in passing up stream. The period of catching is short, limited by migration which usually lasts from three to eight weeks. The larger packing companies have plants located at various points where the fish pass to the stream and transport the work crews from one point to another on succeeding years and sometimes even during the same season depending on the run of the fish, a factor which is fairly well understood at present. Sufficient help is not available at points north of Puget Sound so that supplies, equipment, and men have to be taken to the places each time the plants are operated. They are so far from regular transportation points that special vessels are used. Prior to the war they were all of the sailing type but now operate under their own power. These are some of the factors peculiar to this industry which require that it be conducted along business lines not common to other products.

The nature of the industry made it necessary to develop every form of labor-saving device that is possible, both in the catching of the fish and in their preparation in the factory. It is difficult to say in which the success has been the greater. The power boat makes it possible to go longer distances to sea, to pick up fish at short intervals, and to deliver them to the factory within a few hours after catching, whereas formerly it might take one day or more. Quick delivery of the raw product is the first essential to high quality and that has been solved since icing or cold storage is out of the question in handling such large quantities. Fish which would have been accepted without argument 10 or 15 years ago are now rejected summarily. There has not been as much change in nets, traps, etc., as in the handling after catching. The large scows have given place to smaller speedy craft which can make the trips oftener.

The first notable change in the factory equipment was in the size of the retorts. It was here that the economy of the large horizontal retort was
demonstrated, taking not only a large charge, but on trucks so that the handling could be done without hoists or other power. The capacity of these cookers was three and four times those used for vegetables, and they have since been adopted for many lines, especially on the West Coast. More different types of closures have been designed for these retorts than for the vertical cookers.

The second, though the most distinctive and important development in labor-saving devices is the iron chink, one of the ten outstanding inventions in the canning industry. This is the result of the labor of Edmund Augustine Smith of Seattle, Washington. He made the first machine in 1903 and added improvements each year until his death in 1909. The first patent granted was No. 796,538, August 8, 1905, and provides in a series of automatic operations for cutting off the head, tail, and fins, splitting the fish, drawing the entrails, thoroughly brushing the inside to remove the blood and torn tissue, and then the outside slime. The work is done at the rate of 50 to 60 fish per minute. The only handwork is the placing of the fish so as to cut off the head at the proper point without waste. The limit of the capacity of the machine is the ability of the operator to get the fish in position.

The machine consists of a short table with a knife for cutting off the head and tail, a guide in which to turn the fish tail end with belly up toward the wheel, a wheel having a clamp to seize the fish by the tail, holders to retain the fish in position, knives mounted on adjustable arms set in such position as to cut off the fins, another disk to open the belly, followed immediately by a scraper wheel which removes the viscera, then by revolving brushes which operate on both the inside and outside accompanied by sprays of water to carry off all loose material and slime. The waste is discharged into a flume leading to a scow to be carried to sea or to be converted into fertilizer. Each machine will do the work of from 10 to 15 men and in emergencies when a heavy run is on, they can be operated at full capacity for the entire twenty-four hours.

In order to economize space in the handling of cans, the ends are stamped out and the bodies cut ready for forming, or the bodies may be formed, soldered and collapsed ready to be re-formed, and thus shipped in flat pieces and assembled by machines as used in the factory. This has proven a great convenience and, doubtless, the extension of this practice may be expected in other plants using large quantities of cans.

Another departure has been the adoption of the vacuum closing machine to replace the exhaust box. Heat penetration in the salmon being slow necessitates very large exhaust boxes, requiring not only much floor space but a larger boiler capacity. By developing a machine in which the cans may be sealed while in a vacuum both of these objectionable features of the exhaust box can be eliminated. Furthermore, the exhaust box has always been recognized as a difficult piece of machinery to keep clean, but in the new device provision is made for this contingency.

Fishing

Catching the fish is an especially interesting operation for it is conducted upon a scale not common in other lines. It is lacking in every element of sportsmanship as propounded by the devotees of Walton, but in
APPERTIZING

its place is the cool business of corralling them by the hundreds of thousands. The “Silvery horde” comes from the deep waters to a point in the straits or opposite the mouth of some river or inlet, and in numbers corresponding to the swarming of bees. A ground fish suddenly assumes a surface habit and in a little more time will adapt itself from a salt-water to a fresh-water habitat. The rush is on to reach the spawning grounds which may be hundreds of miles away. The effort of the fisherman is to cross the line of travel by means of nets, seines, or other gear which will admit of taking them in large quantity.

Most of the salmon fishing is done by one of the following methods: gillnetting, trap fishing, purse seining, beach seining, or trolling.

Gillnet fishing is the oldest and most popular method of fishing and is the only type of gear permitted in Bristol Bay where most of the sockeye are packed. There are two types, the floating gillnet and the set gillnet. The former are approximately 900 feet long and 28 meshes deep, the mesh being 51/4 inches stretch measure. The net has a cork line at the top and a lead line at the bottom, and is usually made of linen. The gillnet is handled from a boat designed for the purpose, commonly called “Columbia River type,” about 28 feet long, 9 foot beam, with sail, and manned by two fishermen. The net is dropped overboard and floated with the tide. The fish go against the tide and striking this net are caught around the body in the meshes. The net is pulled in about an hour and a half after the turn of the tide, being drawn in over a roller at the stern of the boat. Floating gillnet fishing requires more skill in setting the net to obtain good hauls than for other types of fishing and attracts to it the highest class of fishermen.

Set gillnets are of the same general type as the floating nets though shorter. They are stretched between stakes near the shore where fish are likely to run at high tide, and are used principally by the natives.

Purse seines are huge nets, 1,000 to 1,200 feet in length and 120 feet in width with floats on the upper cord and heavy rings at the bottom through which a rope is drawn to “purse” or close it. A three-inch mesh is used. The purse seine is handled from a special boat 50 feet or more in length with special gear for lifting the net. A crew of from 7 to 9 men is necessary. A school of fish is located and the seine cast out while the boat makes a circle around them. The seine is pursed and at the same time brought alongside the boat and the fish lifted out by means of a small brail. This style of net is used in Puget Sound, southeastern Alaska, and at various places along the coast to the Aleutian Peninsula.

Beach seines or haul seines are a type designed for use along the Columbia River and Alaskan waters where the fish run close to the shore. The nets vary from 200 to 1,200 feet or more in length, and in width according to the depth of the water. The net is staked at one end and carried out into the stream or bay, then parallel with the shoreline but working against the stream or tide until nearly paid out and then brought to the shore. The net is pulled in by a team or whatever power may be available.

Trap or pound fishing is sometimes described as a permanent form of seine fishing but is more properly a development of the weir. The equipment is of two kinds, fixed and floating, the former used in shallow waters and the latter in deep or exposed waters. The net in this case is fixed in position and of such small mesh that the fish do not become entangled or
injured but directed into a trap or pound corresponding to the bag in the
seine. In fixed traps a straight row of piling is driven from the shore in a
diagonal direction to a point which crosses the line of travel and direct the
fish into the more or less heart-shaped trap or pound. Wire netting is
stretched between the piles. Back from the outer end, a second row of piling
is arranged at an angle to direct the fish along the main barrier and into
the enclosure or pocket. An escape leads from the pocket to either a second
smaller compartment or into a pot. Traps a considerable distance from
the cannery are most often built with two pounds while those which are
close and served at frequent intervals may have only one. The discharge
from the pound to the pot is through a tunnel made of netting. The pot,
a much contracted portion so that the fish are brought close together, is
provided with a bottom and a brail. One end of the brail is fixed and con-
verted into an apron or spiller to direct the fish into the scow or boat when
loading. The other part of the brail covers practically the entire floor when
it is let down, the fish swimming above, and is lifted by means of a line from
the boat winch.

The floating pound is like the fixed except that it is made of heavy tim-
bers fitted and tied together on the bank and is floated into place and
anchored. The net is most often of manilla twine with weights on the lower
cord. All traps are dismantled except during the fishing season. They are
used chiefly in Alaska and their location and operation is regulated by the
Bureau of Fisheries.

Trolling is one method of catching King and Silver salmon, and while
of considerable importance for supplying the fish for the fresh market,
is a very minor factor in canning. Trolling is followed all along the coast
from California northward to southeastern Alaska. An outfit consists of
a small power boat with from 3 to 8 trolling lines. Some of the various
types of spoons are used as lures.

The fish taken from the sea or near the mouth of the rivers are in the
best condition both as to fatness and firmness of flesh. Scows are anchored
near the fishing grounds into which the catch from the small boats are
emptied and are also drawn up along the traps to receive the fish. A system
of accounting on the scow insures the payment to the proper fishermen for
the amount of their catch. The scows are towed to the factory at once so
that the fish be fresh and not subject to deterioration.

The boats are unloaded on conveyors which elevate the fish and deliver
them into the factory at the points desired. Formerly this was done by pew-
ing the fish on a chain elevator with wooden flights but the pew is an ob-
jectionable instrument and has been largely eliminated. Each puncture of
the fish results in injured tissue and becomes a center for decomposition.
Furthermore the dragging of the fish on the elevator results in some injury
so that the most up-to-date method is to flush the fish from the scow into
a boot from which they are elevated to the necessary height and then flumed
to their destination. Heavy sprays of water under fifty pounds pressure
are played over the fish to free them from slime, and a checking tally is
also made.

The size of a salmon cannery is rated by the number of lines, as one,
two, three lines, etc., since each line is practically a complete unit. The
machines are all designed to have approximately the same capacity so that
they can be timed to work in unison. The capacity of the iron chink determines the work for the others. A unit consists of one dressing machine or iron chink, cutting machine, filling machine with its accessory can washing machine and salt feeder, weighing machine, code marker and cover clincher, vacuum closing machine, two retorts, and can washer.

The iron chink is the first machine in line and its operation has already been described. The fish fall from this machine into running water from which they are taken for inspection and for any hand trimming which may be desirable. The fish are then placed crosswise on a conveyor belt with the head end in one direction. The conveyor carries the fish under cutting disks where the body is sectioned to fit the size of can used in packing. Seven knives are in the gang for cutting for tall cans, 13 for No. 1 flat, and 17 for the half-pound flat.

The tail end is diverted to a special chute as it is not canned with the body meat but packed separately.

In the earlier days the cutting was done with a series of semi-circular knives mounted on a shaft, the movement of the knives being actuated by a hand lever. The method is still used in packing small lots of fish for some special purpose.

The filling machine is set close to the cutter. It is an ingenious device to fill large odd-shaped flexible pieces of flesh into a can. The pieces from the cutter are directed so that they feed lengthwise into a pocket somewhat larger than the can. The pocket closes to the proper dimensions and the surplus fish is cut off. The part in the pocket is then pushed into the can. While the fish is being prepared, the cans come through a special guideway, usually from a storeroom above, and in their travel are inverted to insure discharge of any foreign object and are sprayed both inside and out. Just before entering the filler a fourth of an ounce of salt is dropped into the one-pound can, as greater uniformity is obtained in this way than by salting after the fish are placed. The machine, speeded to handle from 100 to 130 cans per minute completes its work by pushing the fish from the measuring box into the can.

The cans are removed on a belt which passes over an automatic weighing machine that removes and segregates those over or under weight. An inspector also removes the cans in which the pieces have been forced in crosswise so as to adjust defects.

Smaller sized cans are most often hand filled as too many pieces are pushed in sidewise by the machine and furthermore it is more desirable that a good cross section be presented than in the case of the tall cans. The appearance on opening a small or flat can is important. If good workmanship is evident, it creates a favorable impression, while a torn or jammed piece is regarded as a mark of carelessness which may pervade the entire factory. Machine packing costs so much less that it is used for economic reasons.

Whether the cans be filled by machine or by hand, it is necessary that they be checked for weight. Overweight may result in springers during warm weather or in high altitudes and thus become unmerchantable, whereas short weight results in slack fill and frequently a sloppy appearance. Moreover, short weight exposes the packer to action under the Food and
Drugs Act. The next step is the clinching of the cover in position prior to sealing in a vacuum chamber. The cover is code marked to show the kind of fish, the factory, date of packing, and other information desirable. The code is valuable in identifying a lot of goods should any question arise at a subsequent time.

The closure is made by a double seamer while the can is inside a vacuum chamber. It is the latest development in closing machinery, and was invented by A. K. Malmquist in 1914, for the purpose of doing away with the huge exhaust box. The steam exhaust box is difficult to keep clean, particularly so because of the nature of the product, and the very large size. Heat penetration is slow in salmon so that from 10 to 12 minutes are required to bring the heat up to 140° F. and even then the results are irregular. The vacuum sealing machine can be regulated to 20, 22, or other number of inches desired and is very nearly constant, with the time of vacuumizing less than two seconds, too brief to remove the gases from the tissues so that the final vacuum is less.

The principal difference between the effect produced by the two methods is that in heat vacuumizing some of the strong fish odor is driven off, whereas it is sealed in the can by the mechanical method. The claim is made that after two or three months the product of the two methods cannot be distinguished. The other advantages are so great that the machines have practically displaced the exhaust box.

The cans are pushed from the closing machine on a table from which they are taken up in lots and placed in strap-iron trays. These trays have a capacity of 145 cans in a single tier, a number which can be lifted by two men without difficulty. The trays are set on small cars, 6 trays high, and wheeled into the retort. From 3 to 5 cars constitute a charge of from 50 to 85 cases. These huge retorts are of special interest because first developed for this industry to be handled by two men without the aid of power machinery. They also effect an economy in plumbing or steam fitting and control apparatus. Free venting is done at both top and bottom of each end to be certain that no air pockets are formed while the temperature is being brought up, after which the vents are reduced and the temperature control becomes automatic.

The time required for safety in cooking is about 90 minutes at 240° F. for one-pound tall cans, 80 minutes for No. 1 flat cans, and 75 minutes for one-half pound flat cans. In order that the bones be properly softened, especially with large fish, it may be necessary to cook for a longer time, that is, up to 120 minutes, or to raise the temperature to 245° F. The longer period slows up the work in the factory, and the higher temperature gives a more pronounced cooked flavor so that the canner must make his choice accordingly. In the north and central Alaska sectors the tendency is to raise the temperature, while in the southeastern sector and Washington more attention is paid to varying the time factor. The condition of the fish as to dryness, variety, time out of the water, temperature of the weather, may all influence cooking within narrow limits. From 5 to 7 minutes additional are allowed for bringing up the temperature of the retort and as much more for blowing it off before opening the doors. Salmon cans are not usually cooled with water but allowed to stand in the air.
When the cooking is completed, the trays, still holding the cans, are removed from the retorts and wheeled to the washing machine. The trays are deposited on a conveyor which carries them through one tank containing a hot cleaning solution and then through a raised tunnel where they are sprayed with hot water to remove the alkali or cleaner, and finally through a second tank of hot water. This treatment removes all traces of oil and grease. Any imperfect cans observed while passing through this process are removed.

The trays are again stacked six high on trucks with two wooden strips about 1 1/2 inches square placed between the trays to give ventilation so that cooling may take place more rapidly. The trucks are allowed to stand under sheds until cool before stacking the cans in the warehouse or casing them. An almost universal practice is to test for leakers by tapping with a short steel bar. The note indicates to the trained ear the difference between a sound can and one that leaks or is otherwise defective. While the number of such cans is small, it is necessary to make close inspection to avoid the unpleasant results of an occasional spoiled can of fish.

**Label Weights**


A modern one line plant will pack approximately 1,400 to 1,600 cases of salmon per day and requires about 40 men for its operation. This number includes not only the men who actually operate the line but also cooks, waiters, etc., of the commissary department.

**Specialties**

Two unimportant specialties may be mentioned: mild and hard smoked. For the first, the fish is mildly cured and lightly smoked to avoid a too pronounced flavor. The fresh fish are cleaned and split, put in cold 50 degree brine from 12 to 16 hours, allowed to hang and drain from 4 to 6 hours, then smoked with a cool smoke from 8 to 12 hours. The fish are cut, filled into the can (but no salt added), and cooked the same as fresh salmon.

Hard smoked salmon are placed in 90 degree brine from 8 to 12 hours, hung for 6 hours, then smoked for about 24 hours. They are allowed to hang for a day or two then packed in glass under vacuum. They are also sliced, oil added, and processed the same as fresh fish.

**SARDINES**

*Clupea harengus. Sardinia caerulea.*

The term sardine is a sort of anomaly in food nomenclature. While it is an old term, it was not applied at first to a specific variety of fish while in its native habitat prior to being prepared for food. It can be traced back to about 1400, and for a long time thereafter it seems to have been used to designate any small or young fish, similar to the use of the term minnow. After fish were prepared in a certain way, which will be described, several
different species became known as sardines, and by extension the name was applied to the fish while in the sea. The origin of the term in connection with the prepared fish is believed to be substantially as follows:

The Island of Sardinia, off the coast of Italy, was the site of the most prosperous tunny fishing in the Mediterranean. The variety caught in the locality was small but of excellent quality, and sometimes called “sardines.” At times when the fish could not be caught, the natives busied themselves by catching young pilchards, brining them lightly, drying them for a short time in the air, then frying them in olive oil. These were called sardines, whether first by those who prepared them or those who purchased them is not clear. These fish made in reality a delicatessen product which would keep longer than when cooked in the usual way, and were of such excellence and in such demand that it was not long until they were imitated in other parts of Italy, and also in Spain and France. Centuries later, when canning became an art, these fish were prepared in essentially the same way before they were placed in the container and became known as sardines. The closest approach to this method of preparation was used by the Dutch in the preservation of salmon in 1800, a description of which is reproduced from “Preservation of Fishery Products for Food.”*

“As soon as the fish is caught they cut off the end of the snout (head) and hang it up by the tail to let the blood flow out as much as possible. A short time after they open its belly and empty it and wash it carefully. Then they boil it whole or in a brine in white salt, often skimmed. Before it is quite boiled (cooked), they take it out of the brine and are careful not to injure the skin, after which they let it cook and drip on a hurrite. Then they expose it for a day or two to the smoke of a fire made of juniper, which must make no flame. Finally, they put it into a tin box, the sides of which must be an inch higher than the thickness of the fish, and fill up the box with fresh butter, salted and melted. When the butter is coagulated, they put on the cover and solder it to the lower part of the box. Some persons eat the fish without boiling it again, but it is better when it gets a second boiling. In winter, good oil of olives may be used instead of butter.”

These were the first fish to be packed in tin cans and were not cooked after sealing the can so that the product kept only fairly well and was in reality preserved by the smoking and the hot butter or oil. It is believed that the Norwegians borrowed the idea of smoking sardines from this Dutch practice, and smoking is regarded as a refinement used on the highest grade which they pack.

A term which has been so loosely used naturally has given rise to frequent controversy as to just what a sardine is. In Italy it is the young pilchard; in Spain, Portugal, and France, both pilchards and sprats are used in the preparation; in Norway, the bristling; in this country, the young herring on the East Coast and the pilchard on the West Coast; and in Japan, a herring. These all belong to the herring family so that a ruling under the Federal Food and Drugs Regulations permits the term to be applied to any young herring, but if packed in a foreign country the label must indicate the place of origin.

Domestic Sardines

The fish used for packing sardines on the eastern coast is *Clupea harengus*, found along nearly the whole of the Atlantic seaboard, but in the best condition for food and in greatest abundance in the waters of Maine and Nova Scotia. They occur at all seasons, and may be taken from April 15 to December 15 but are not plentiful before June. The best runs are generally in August and September. The fish has an elongated body, slightly compressed, covered with thin scales, dark colored above, and silvery on the sides and below. There are all lengths up to 15 inches but those used for canning run from 5½ to 8 inches. The flesh is rather dark, bony, but at certain stages is moderately oily with a good flavor. The bones become softened and disintegrated from the cooking and so are not noticeable in the canned product.

History

The canning of sardines had its origin in Nantes, France, in 1834, but not with that degree of success to be considered the beginning of an industry until about 1845. The equipment was the simplest kind imaginable; a small tank in which to brine the fish, sticks on which to string them while drying in the air, wire rack in which they were placed one at a time and so spaced that they would not touch each other, a deep pan with oil heated over a direct fire, and an open boiler in which to heat the cans after they were sealed. A close approximation to the very simple equipment and the method used is to be found in the packing of sardines in Brittany at the present time.

Many have wondered why the particular method was used with sardines instead of packing them in the can uncooked as salmon and some other fish. That is easily understood when one considers that Appert taught that the preliminary preparation of meats and fish should follow along the same lines as the preparation for the table and his successors adhered very closely to his methods. It was only natural then that the methods used in the best preparation of the fish should be used in this case. Furthermore, later accounts show that the French learned very quickly that the raw fish would not only stick together but become mushy if cooked in the can, and that the cooking in the oil prevented both of these objectionable mishaps and at the same time improved the flavor. The evolution in the method of preparation has been slow, but the volume handled is the best possible commentary upon the quality of the product.

The birthplace of the industry in this country was Eastport, Maine, in a lobster cannery in 1867, but following the history of its predecessor in France, it did not become a success until 1875. The credit for the work is given to Julius Wolf of New York. As soon as it leaked out that the fish were being canned according to European methods and bringing the fabulous price of $12 per case, the inexperienced did not fear to rush in, and by 1880 there were factories at Eastport, Robinson, Lubec, Jonesport, East Lamoine, and Camden, Maine. These must have been the forebears of a hardly and numerous race for that experience has been repeated many times and at divers places and upon sundry products. They brought to the industry native mechanical ability which found expression in appliances to lessen the amount of hand labor and to give better control over the operations in manufacture. Production was placed upon a volume basis, and, as in other
lines of canning, the whole subject is being given a new study at present to improve both the methods of preparation and the quality of the product.

The difference between the foreign and domestic methods and objectives is tersely stated in the first and second paragraphs in the summary on "Sardines," Tariff Information Surveys, United States Tariff Commission, 1925.

"The canning of sardines is an important industry in France, Norway, Portugal, Spain, and the United States. Practically all domestic sardines are produced in Maine and California. Between the great bulk of imported sardines and about 90 per cent of the domestic product, there is virtually no direct competition. The foreign and domestic products are widely different in price, quality, and appearance, the former being packed in olive oil and the latter principally in cottonseed oil, tomato sauce, and mustard sauce. Only about 5 per cent of the Maine and California products are similar in packing to the foreign sardine.

"The domestic industry utilizes machine processes to a much greater extent than does the foreign. It aims at mass production without elaborate care in the necessary hand processes. It is in the hand processes that the Europeans excel, exercising as they do greater care in handling, grading, and packing."

Statistics

The value of sardines packed since 1920 is shown by comparison with other fisheries products in the table at the head of this section. A more favorable showing is made for sardines on the basis of volume than on the basis of value as this fish is the lowest in price among canned foods.

Atlantic Coast Methods

The fishing season on the East Coast begins about April 15 and continues until about December 15 but the principal catch is made during July and August.

The herring run in schools near the surface of the water, and come close to the shore to feed. They are caught principally in traps called weirs which are built out from the shore into the line of travel which the fish normally follow in their migration. These were formerly constructed of stakes driven into the earth with brush woven between. The stakes began at the shore and extended out into the open water in a heart shape, an indentation being made on one side to afford an opening for the entrance of the fish. A line of stakes with brush might also be conducted outward for some distance to divert the fish into the weir. By turning the passage inward for a short distance the fish are diverted past the opening in their course of swimming so they do not find their way out. In the newer traps, strong webbing is used to take the place of the brush.

The fish find their way into the weirs and are left for twenty-four hours to rid themselves of feed. They are then lifted from the water by means of a net and loaded into the hold of the collecting boat, which in this case is always a motorboat. The fish are kept in thin layers and in rather small compartments in the hold to protect them from flattening due to superimposed weight and from injury due to the rolling of the boat. Fish which are flattened or the skin broken or loosened simply become waste, which is
unprofitable to both the fishermen and the factory. The fish are brought in promptly as they begin to deteriorate soon after being taken out of the water. This is particularly true for any which contain red feed. The distance to the factory in most cases is such that little time is required for landing the catch. If for any reason the fish must be held, they are partly salted in the hold at a rate of from 200 to 500 pounds of salt per hogshead (1,200 pounds).

Weber gives the following count of fish per thousand pounds for the different sizes: Length of fish 4 inches, 51,000; 5 inches, 33,000; 6 inches, 22,500; 7 inches, 9,000; and 8 inches, 7,200.

Factory Operations

At the factory the fish are scooped into large buckets, weighed, hoisted to a point where they can be delivered to either the brine vats by sluices or to the trimming tables by means of overhead tracks. If the fish be handled in buckets, a heavy stream of water is played upon them. If they be turned into a flume, they are washed by the running water. Formerly all fish were put into brine as a preliminary step but a change was inaugurated about 1920 to immediate evisceration to avert the damage which may arise from the fish containing red feed. Holding the fish in the weirs and quick delivery to the factory go far toward solving the problem and immediate dressing insures against any loss from this cause.

Dressing

The dressing table consists of a long flattened trough in which the fish are distributed and with the operators stationed on either side. Three or four fish are taken up in the left hand and the heads cut off by a pair of special shears or a knife, and by a second movement the viscera is drawn out. The waste drops through a chute into one pan and the beheaded fish into another, both being removed at short intervals. Sufficient inspection is given to prevent careless workmanship and unnecessary waste. Among other advantages in the dressing at this point is that there is less material handled through the factory, the capacity of the flakes is increased from 20 to 25 per cent, and greater uniformity in salting is secured, especially of the larger sizes. The disadvantage is that more fish become roughened in the handling. A number of machines have been invented for doing this work, starting about 1912, but most of them have not equalled good hand work. The first one to be really successful was developed in the plant of William Underwood Company. Machines are much better adapted for handling the larger fish such as occur on the West Coast.

Brining

The brine tanks are made of strong planks about 2 to 2½ feet in depth, 3 feet in width, and 5 feet long, or in some cases two or three units in length may be built together.

The brine is made strong, testing from 90 to 100 degrees on the salinometer, or 25 per cent salt, and the volume of brine made double that of the fish to be treated. The time of treatment varies from 20 minutes to 2 hours depending upon the size of the fish, fatness, and the temperature. The average time is about 40 minutes. The fish remain in the brine until they show evidence of tissue hardening or being “struck,” to use the factory
phrase. If the fish are beheaded and eviscerated, the time is reduced by from one-third to one-half that for whole fish. The shorter the time the fish are in the brine and get the desired result, the better. This is one of the reasons why it is best not to salt the fish on the boat on the way to the factory. The proper stage for removing the fish from the brine is learned from experience and not from directions.

In the brining process, salt enters the tissues and some moisture and extractives are drawn out with a slight loss in weight. The per cent of salt taken up by the fish varies, and this is accentuated in the final product by the amount of drying. For small fish a total salt content of from 2.5 to 3.5 per cent is considered best.

When the brine is drawn off, and the fish rinsed in fresh water, they are ready for flaking.

### Flaking

The operation of spreading the fish in a single layer on slat or wire screens is known as flaking. The frames, from 18 to 22 inches wide and 3 feet long, were first made of thin strips of wood, but for a long time they have been made of wire bound to a stiff frame. The units are designed to fit the flaking machine and the racks which are used to carry them into the dryer and for holding them while cooling. An average of 100 whole fish or 125 headless fish can be spread on the trays without touching. In the beginning the work of placing the fish had to be done by hand, but since 1912 most of it has been done by machine, the flakes being carried through on a conveyor. The work is not perfect but needs only a little handwork to correct the overlapping.

### Drying

From the inception of the industry at Eastport, the canners recognized that natural outdoor drying was too slow and uncertain for their use. There were too many foggy days, and more or less decomposition might occur before the fish were fit to fry. Special frames were made in which the flakes could be laid on a slight incline, one above another with sufficient space between for the circulation of air. The frames were brought into rooms, and heat generated in a furnace below, passed upward through them and out at the roof. This was a decided improvement and reduced the time of drying to a few hours instead of a day or more.

How slowly the essential principles were grasped is revealed in a patent, No. 223,682, granted to Henry Sellman, January 20, 1880. It was for first steaming the fish to partly dry them, then subjecting them to a dry heat, after which they might or might not be fried in oil. The apparatus was the one most used for a number of years and the principle is followed in other developments up to the present.

The text is so informative of the most advanced views held at the time that the important part is reproduced:

**Sellman Patent**

Our invention relates to an improved method of preparing fish for preserving in oil, mustard, sauces, spices, or vinegar; and it consists in subjecting the same to the process of steaming and baking, in a manner to be hereinafter more fully set forth.

The method hitherto in use of preparing fish for the purposes indicated is as follows: After the fish are landed, they are subjected to the process of decapitation and
APPERTIZING

821

...suitable for drying to a certain extent, after the fish have been sufficiently dried by exposure to the atmosphere or to an artificial current of warm dry air. They are then washed clean and placed in shallow wire baskets, or any other suitable receptacle, and immersed in oil suitable in quality and heated to a certain degree for the purpose of frying and expelling from the fish any parts of water which remain in them after the drying process. They are then allowed to drain, and are packed in tin cans. This mode of drying by natural or artificial currents of air and frying the fish in oil is, for the reasons hereinafter stated, very deleterious to the quality of the article of fish to be put up, and the invention herein set forth tends to do away with and overcome the former objectionable method. The fish used for the purpose indicated are of a very tender and delicate nature. They do not admit of much handling, and owing to the delicacy of nature, are subject to very rapid decomposition, as they should be salted very lightly.

The process of drying the fish, either in open air or by an artificial current of warm dry air, takes so much time that a decomposition of the fish to a greater or lesser extent is unavoidable, as three to twenty-four hours are consumed in drying the fish sufficiently by the modes indicated.

In frying the fish in oil, as now practiced, the quality of the oil in which quantities of fish are fried is rapidly deteriorated by the water from the fish, which is not evaporated, and from the gluten from the fish passing into it. A large percentage of the fish is also lost by breaking during the process of frying in oil.

In our improved process, the fish, after landing, are decapitated, disentrailed, salted, and washed. They are then spread on wire-netting or other frames, a, made of any suitable metal and of any suitable size. They are then subjected to a process of steaming by live steam, which is injected from a steam-boiler into an upright chamber, A, of suitable size, lined with sheet metal, and provided with narrow internal flanges or shelves b upon which rest the wire frames which hold the fish. The steam passes through the closed box and escapes through an opening in the side or end opposite to where it is introduced. A door, c, opening outward, is also provided, for obvious reasons.

The time consumed in this process is from 10 to 20 minutes, according to the power of the steam employed, and may be performed within 2 hours after the fish are first landed. The steaming process has the effect of evaporating the water from the fish in a much more thorough manner than by the old process. It has also the effect to prepare the fish for the subsequent baking process, and by killing any germs in them preventing rapid decomposition, keeping them sweet, and retaining their natural flavor. After the steaming process the fish (which remain on the same frames, a, on which they were steamed) are subjected to the baking heat of a revolving reel-oven, B, operated by steam or any other power, until they are fully cooked or baked. They are then taken from the revolving reel-oven cooled a certain time, then packed in tin cans which are supplied with fine oil, mustard, sauces, spices, or vinegar, as desired. The cans are then soldered and subjected to the action of a bath of boiling water for a certain period, for the purpose of expelling all air from the cans by the usual process.

The essence of the whole mode of procedure consists in preserving the fish against decomposition by steaming and baking, as set forth, thus preventing breaking of the skin, curling and breaking of the body, and thus evaporating from the fish all water, and then while in this baked condition, subjecting them to the preserving process of canning similar to that practiced with sardines, inclosing in tin cans with oil, mustard, spices, etc.

It is known that small fish have been prepared and preserved entire by gutting, placing salt inside, steaming, and afterward drying by a stove and a current of hot air; and small fish have also been steamed at the boiling point of water, then cooled, and canned in oil. They have also been canned in vinegar and in spices.

The comparative merits of frying in oil and baking in an oven did not pass unnoticed and their advantages are set forth by R. E. Earll in the United States Fish Commission Bulletin for 1887.

"It is said that the fish which have been fried have a better flavor, and having absorbed more oil, keep longer than those baked in an oven. It is claimed, however, by those using ovens, that by the baking process very much depends upon the skill of the baker, and that at its best it may pro-
duce results equal, if not superior, to those of the old system. It appears
that the first fish fried in a given quantity of oil are better than the best
baked fish, but that, as it is necessary, in order to keep the expenses within
reasonable limits, to use the same oil for frying successively a great many
pans of fish, the fluid soon becomes filled with scales and small particles of
fish, which burn on the bottom and impart to the product a bitter and un-
pleasant taste. In baking, on the other hand, when it is properly done, the
fish are all of a quality equally good."

The first modification of this drying method was the continuous belt for
carrying the flakes and later the use of the woven wire belt to take the place
of the separate flakes. The belt was driven through a long tunnel entering
directly from the flaking table or machine and passing against a strong cur-
rent of heated air to carry off the moisture, thus making the operation con-
tinuous.

The method most commonly employed is that of steaming the fish pre-
paratory to packing. The fish are flaked by machines and placed upon racks
which are run into horizontal steam chambers, the door closed, dry steam
turned on from a boiler carrying 60 pounds or more pressure, the blow-off
left wide open to facilitate rapid circulation of the hot steam without build-
ing up pressure, steaming from 5 to 15 minutes, then opening and remov-
ing the racks into a room where the fish are cooled in a current of air. The
time of both heating and cooling varies with the efficiency of the apparatus
used. It is essential that the fish be cold before handling, otherwise the skin
loosens resulting in a poor appearance in the can.

Frying

Drying the fish in hot air by a short steaming and baking was not con-
sidered sufficient to give a canned product of the highest quality or not equal
to the imported. Frying was therefore used to supplement the drying.

The first fryers were long narrow shallow pans set in masonry and
heated directly by fire. The width was slightly more than the flake so that
it could be suspended from the side by means of hooks. Cottonseed oil
was used and only in sufficient quantity to cover the fish. The theory was
that some of the fish oil was abstracted or replaced by the vegetable oil, thus
removing a part of the strong fish flavor. The time in frying varied from
one and one-half to six minutes depending upon the size and condition of
the fish, the operation being complete when the backbone could be lifted
out by the tail.

In the frying process a certain amount of water as well as oil was ab-
stracted and there was also some loosening of scales and bits of tissue, all
of which affected the cooking oil so that after repeated use it was anything
but attractive. The direct heating of some of the particles on the pan im-
parted a poor flavor and furthermore there were wide variations in temper-
ature that could not be controlled.

The first improvement came in the use of a closed steam coil for heating
the oil as it gave a greater uniformity in the cooking. Another innovation
occurring almost simultaneously was a change to a deeper and longer fryer
provided with a conveyor so that the flakes or baskets could be carried
through automatically in a given time, a direct change for the better, made
in 1884. Subsequently the tank was increased to about one foot in depth
and the coils raised three or four inches above the bottom. Water was introduced to a point just below the coil and oil above to the desired depth. The oil was heated to 230° F. and although in contact with the water the latter did not come to the boil. The water and debris from the fish passed through the oil into the water below and could be removed at short intervals. Filtering and centrifuging the cooking oil were gradually introduced and assisted in getting rid of suspended matter but not of the acquired flavor. There is no treatment that compensates for fresh oil.

As far as can be determined from the records available, no olive oil was ever used in the large fryers in this country but cottonseed oil instead. Corn oil and peanut oil have been used in very limited amounts owing to their higher cost.

Weber points out that one of the reasons for the superiority of oil fried fish is that the moisture content is reduced to about 64 to 65 per cent, or lower than in the steam or oven dried fish. He further points out a most astonishing variation in the drying of fish as delivered to the canning table. This varies from as little as .03 per cent to as much as 32.22 per cent loss of water, the average being about 13 per cent.

**Filling the Cans**

The flakes are distributed to the packers who nip the heads from those which were brined whole and trim the bodies of the others to fit the can. Care is exercised to select fish of nearly the same size as they are layered so that they present the maximum of the silvery surface upon opening the can. A great deal is done to make the pack attractive necessitating skilful work in order to produce a superior brand. This is much more important with the small fish than with the large ones. The number of fish per can varies from 5 to 15 for the regular one-quarter size can which constitutes fully 80 per cent of the Eastern pack. It requires about ten flakes of fish to fill one case of 100 cans.

Oil, cottonseed or corn, is next added by machine. There are two types in common use, one in which the cans are first set on trays, 20 cans being oiled at a time, and the other in which the cans pass single file through the machine to receive the proper allotment and then to the closing machine. The practice of filling oil into the cans before placing the fish is a messy method.

According to Weber, corn oil gives the best flavored product due to the fact that it adds none of its own, and winter-pressed cottonseed is second. The price generally favors the latter. The quantity is 3 quarts per case on standard fish and 3½ quarts per case on extra standard and fancy grades. Olive oil is used occasionally upon special orders.

Instead of oil, a mustard sauce, tomato sauce, or special sauce may be used, especially if the fish be a little large or show more or less roughening from handling.

**Sealing**

The shape of the sardine can precludes the use of the regular double seamer, but other types have been developed which give it a tight seam. The depressed top, a development of 1884, was for the purpose of avoiding the venting of the cans. By depressing the top the head-space was
limited and the air driven out of the can as the soldering iron followed around the edge in making the closure. Key opening cans to remove the entire top or a strip from the side are used extensively.

Cooking

The closed cans are cooked either in an open bath for from an hour and a half to two hours and a quarter or in a retort at 224° to 240° F. for from 25 to 30 minutes. The fish are easily sterilized and there seems to be no valid excuse for injuring them by excessively high temperatures to comply with a theoretical condition. They must be cooked long enough to soften the bones and this usually requires as much or more time than is necessary for sterilization. Weber reported in 1920 that only one Eastern factory used a retort in cooking at that time but all are said to be so equipped at present.

As the cans come from the cooker they are covered with a film of oil which formerly was removed by tumbling them gently with sawdust, after which they were cooled in the air and finally wiped. The use of an alkaline bath and a hot water spray is more effective for the purpose with the further advantage that the cans are not handled so roughly.

Cans Used

Sardine canning requires the use of special cans to hold the fish in a fixed position in order to present an attractive appearance to the consumer. From the beginning small flat oblong cans have been used in three sizes to hold approximately one-quarter, one-half and three-quarters pound, the one-quarter size greatly predominating. Some variations have been made to more nearly fit the fish and reduce the waste but have not been profitable. The saving in fish did not pay for the extra trouble of multiple sizes in cans. The dimensions of the standard cans are as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-quarter</td>
<td>4 6/32 inches</td>
<td>2 3/16 inches</td>
<td>5 3/8 inches</td>
</tr>
<tr>
<td>One-half</td>
<td>43 2/3 inches</td>
<td>3 1/4 inches</td>
<td>1 25/32 inches</td>
</tr>
<tr>
<td>Three-quarters</td>
<td>4 3/8 inches</td>
<td>3 1/2 inches</td>
<td>1 3/8 inches</td>
</tr>
</tbody>
</table>

The first cans were made of three pieces, soldered, and rough in appearance. They were flat on the top and bottom so that it was necessary to take them out of the bath after they had been heated, vented, then returned to the bath to complete the cooking. The depressed top, invented in 1884 simplified this procedure since all air was driven out in the soldering. Machine made cans were introduced in 1900 and have been used exclusively since 1904 but modified to the open top type in 1918.

Plain tin is used for the standard grades and C-enamel for fancy packs. The outside may or may not be lithographed.

Troubles

The packing of the Eastern sardine has been accompanied by much trouble, the worst of which has been a form of decomposition known as “belly blown” or “feedy fish” occasioned by the fish feeding upon small marine life including some shrimp-like forms. These are known to the fishermen as red feed and associated with them are very active micro-organisms. Shortly after the herring are taken, if they have red feed in their stomachs,
enzymic action results, breaking down the tissues of the intestine and belly wall, with distension and rupture by the gas formed through the action of the bacteria.

After the cause was discovered in 1918, the prevention became easy by keeping the fish in the weir for twenty-four hours to rid them of visceral contents. The practice of quick delivery of the fish to the factory and immediate evisceration has the same effect. Doubtless aesthetic considerations will require this step to be taken in time for all fish.

**Pacific Coast Sardine**

The fish which is known and packed as a sardine on the Pacific Coast is *Sardina caerulea*, very closely related to the pilchard of the Mediterranean waters. It is a much larger fish than the herring of the eastern shore, in fact so much larger that it was called a mackerel when canning was first begun, and the term “sardine” was not especially in good repute. The change in designation was made to comply with the Pure Food Regulations. Now it is SARDINE, all capital letters, to distinguish it as the real sardine, not an immature herring.

The fish has the same general appearance as the Eastern herring but is larger when it arrives at the coastal feeding grounds. The life cycle of this fish is not known to a certainty. They are believed to spawn in the Japan current some three hundred or more miles off shore, to migrate toward the coast opposite Lower California and attract attention first when they are south of San Diego. At that time they are small, averaging from five to six inches in length and are supposed to be a year old or possibly more. The small fish taken in this area are packed in quarter cans after the style of the Eastern pack and in Europe. Practically all the small sardines packed on the West Coast originate here as more than two-thirds of the fish grade small. By the time the fish arrive opposite San Pedro they are between seven and nine inches in length and 75 per cent are classed as large. When the fish arrive in the vicinity of Monterey and northward they are full grown or from nine to twelve inches in length, less than 10 per cent being classed as small. The large fish are then in their prime, packing from five to eight in a one pound oval can. The migration continues up the coast but in broken schools after passing the Golden Gate and when they are between the Columbia River and Vancouver they are believed to turn westward again to the Japan current to spawn, the young being carried south to repeat the cycle.

The principal canning is done at San Diego, San Pedro, Monterey, and recently at Pittsburgh located at the upper end of San Francisco Bay. The larger fish and the larger package place it in the same class with salmon, as the principal part of a meal rather than as an accessory or appetizer. It heads the list of inexpensive flesh food, often selling at retail below ten cents per pound.

The packing of the large fish differs from the small in that the latter are packed primarily as a food product while the large ones are a costly by-product of an otherwise profitable meal and oil industry. The California conservation law requires that at least 13.5 cases of sardines must be packed for each ton of fish used for meal or other non-food product. This has resulted in experimental work being done to eliminate much of the labor and other expensive steps in preparation.
The packing season in northern California is from August 1 to February 15, and in southern waters from November 1 to March 15.

History

The packing of sardines was first attempted on the western coast at San Francisco by the Golden Gate Packing Company in 1889 who continued to operate on a small scale until 1893. During the five years they put up about 20,000 cases of quarter cans and 7,000 cases of one-pound oval cans. The factory closed in August of the last year owing to the irregularity of the runs of fish and ineffectual methods of catching them. Later the equipment was purchased by A. P. Halfhill at San Pedro and he pioneered the industry there. F. E. Booth began experimenting in the packing in Monterey in 1901 and following that a number of plants were opened along the coast.

The growth of the industry is indicated by the statistics of the number of cases packed since 1912.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1912</td>
<td>18,774</td>
<td>1920</td>
<td>1,062,996</td>
<td>1928</td>
<td>2,815,330</td>
</tr>
<tr>
<td>1913</td>
<td>73,686</td>
<td>1921</td>
<td>389,112</td>
<td>1929</td>
<td>3,941,459</td>
</tr>
<tr>
<td>1914</td>
<td>80,834</td>
<td>1922</td>
<td>729,034</td>
<td>1930</td>
<td>3,069,524</td>
</tr>
<tr>
<td>1915</td>
<td>47,234</td>
<td>1923</td>
<td>1,132,023</td>
<td>1931</td>
<td>1,794,991</td>
</tr>
<tr>
<td>1916</td>
<td>166,095</td>
<td>1924</td>
<td>1,420,128</td>
<td>1932</td>
<td>1,001,845</td>
</tr>
<tr>
<td>1917</td>
<td>1,190,194</td>
<td>1925</td>
<td>1,752,779</td>
<td>1933</td>
<td>1,446,530</td>
</tr>
<tr>
<td>1918</td>
<td>1,484,979</td>
<td>1926</td>
<td>2,163,755</td>
<td>1934</td>
<td>2,051,736</td>
</tr>
<tr>
<td>1919</td>
<td>1,151,515</td>
<td>1927</td>
<td>2,625,412</td>
<td>1935</td>
<td>2,447,137</td>
</tr>
</tbody>
</table>

Fishing

The methods in fishing are totally different from those used on the eastern coast since the work is done in open water on dark nights with nets and other equipment developed for the purpose. The methods of catching, while based on old principles, have undergone an evolution no less marked than those concerned with the preparation of the raw material for the can. The earliest equipment consisted of a sailboat about thirty feet in length and a small mesh gillnet with which only small catches could be taken and these were uncertain. Moreover the sardine is a delicate fish and catching and removing them from the net results in injuries detrimental to the fish, which doubtless had something to do with retarding the development of the industry at its inception.

The second step was the introduction of the purse seine but as the earlier ones were built with insufficient depth and the fishermen were inexperienced, the catches were generally poor though a very marked improvement over the gillnet. The lampara net, developed in the Mediterranean, was introduced from Tangeria in 1905 and marks the beginning of better fishing. The net which was imported was not up to expectations but as modified by experience and familiarity with its use, it soon met the requirements. This net is from 900 to 1,500 feet in length and consists of three parts, two side wings with cork and lead lines to hold them vertical in the water, attached to either side of a central portion called the bag. The wings are first spread out then brought together so as to encircle the school of fish and by closing from the outer ends the fish are directed into the bag. The bag is usually about 240 feet around at the top and 120 feet in depth. Each wing is about 360 feet in length and has been increased in depth to about 180 feet. The mesh varies in different parts depending upon whether the part serves to direct the fish into the bag, to hold them in the bag, or serves
under strain in lifting the load. This type of net was used almost exclusively until 1930 but since then has been giving way to the purse seine. From 8 to 10 men are required for a lampara crew.

The introduction of the gasoline engine in 1927 had much to do with changing the equipment, in increasing the size of the boat and in making it more independent of weather conditions, giving it a greater fishing radius, and ability to operate in the open sea. The boats were generally increased to 45 feet for the lampara gear but have since been increased to 75 feet in length, 12 to 14 feet beam, and 5 feet in depth, powered with 100 to 150 horsepower Diesel engines. They are capable of carrying a hundred tons of fish or even more.

The purse seine has gained in favor in the past five years and is now made from 1,200 to 1,500 feet in length and from 150 to 180 feet in depth. The netting is 1¼ inches mesh, the twine varying from heavy at the top or corkline to light at the lead line. The net, rings for pursing, weights, lines, etc., bring the total weight to from 4 to 5 tons. It is handled on a turntable at the stern of the boat and lifted from the water by a power hoist. An open boat is also carried for setting or manipulating the net. The purse seine crew consists of 7 or 11 men.

The purse seine is simpler in construction than the lampara type, is more easily handled off and on the boat, and not subject to wind and tide to the same extent. In one form of lampara gear the wings are provided with rings and purseline so as to use this feature when desired.

The fishing is done at night during the dark of the moon, the school being located by the phosphorescent lumination which they cause at the surface of the water. The lookout from the crows-nest directs the boat along the luminous area and if he decides the school is sufficiently large to make a profitable catch, the small boat is lowered and one end of the net located as large an area as possible, due care being given with respect to the direction of the wind and running of the tide. This precaution is more important with the lampara gear than with the purse seine.

When the fish are surrounded, the lower or lead line is gradually closed or pursed ahead of the cork line to prevent the fish from going down and escaping. A late device is to lower an electric light on a cable and flash the light on and off to frighten the fish so as to keep them near the surface. When the net is finally pursed, the boat is worked alongside. The captain can judge fairly well the size of the catch and if too many are trapped a part may be allowed to escape. The fish are lifted from the purse by means of a brail net operated by the power winch. The final step is to haul in the net taking care to pile it so that it may be cast again. From one to four sets, depending on the size of the catch, are made in a night.

Owing to the fact that the work is done when there is no sun and the air is cool, the fish remain perfectly fresh without ice or other protection for several hours and in the meantime they are on their way to the canning factory.

The small power boats first used cost from $2,500 to $4,000, the late 75 footers cost from $12,000 to $15,000. Nets cost from $1,500 to $3,500 and under good handling may last two years.
Payment for the fresh fish is made at a stipulated price per ton (about $7 to $9) in which the men share alike, and the boat and gear at an agreed percentage on the catch. The fishing is done principally by Italians, Japanese, and others of foreign birth or ancestry.

Factory Operations

Until 1927, the unloading was done by scooping the fish into large buckets and hoisting them high enough to permit the fish to pass through the factory by gravity. This might mean lifting them twenty feet or more above the dock. They were unloaded into a hopper that discharged them into the scaling machine. This is a simple squirrel-cage washer with a reel 20 feet in length and from 30 to 34 inches in diameter, using 1/2-inch mesh screen. By moderate rotation and keeping a constant quantity of fish passing through, it is effective in removing the scales and especially when aided by small sprays under considerable pressure. If the buckets be dumped without distributing the fish so that they go through in lots or if the sprays be inadequate, neither the scales nor slime are all removed. The scalers have a capacity of about 5 tons per hour.

It is more desirable that the scaling be done before the fish are cut than by a separate operation after cutting.

The latest improvement in unloading and carrying the fish to the factory is through a large eight inch pipe, by the aid of water and a pump. The unloading of the boat is made much easier and at a constant rate. The discharge is directly into the scaler and thereafter they follow the regular course.

Cutting

The fish are discharged from the scaler into flumes which carry them to the tables or upon conveyors to accomplish the same end, all depending upon the arrangement of the factory or the volume of fish to be handled. A simple table with a raised wooden edge to prevent the fish from slipping over and to furnish a resting place for cutting is all that is needed. The operation consists in holding the fish on its belly, cutting it transversely back of the head and by a deft twist of the point of the knife tearing off the head and drawing out the entrails. It is an operation in which the Japanese women are particularly skilful and work with such rapidity that the best among them will handle 300 pounds per hour. The refuse falls into a chute and is carried off for by-products as oil, meal, and fertilizer and the dressed fish are filled into buckets to be weighed and sent to the brine tanks.

A half dozen or more cutting machines have been patented within a decade and at least three are equal to average hand work. The fish feed into the machine head first, they are cut squarely across back of the head, a revolving burr extracts the intestine, or it may be sucked out by a vacuum apparatus, or the cut may be incomplete and the intestine accompanied by a strip of the belly wall may be torn out. The work is supplemented by inspection and hand trimming when necessary.

Brining

Brining follows essentially the same course as that used for Eastern sardines, though the operation is not regarded as being equally important with the larger size fish. The brine is made nearly saturated or testing from
90 to 100 degrees when large fish are handled and about 75 degrees for the smaller ones. The time required is from 1 to 1½ hours for the large size, and from 25 to 40 minutes for the small ones. At the end of that time the brine is drawn off and if the fish be held, they are covered with water. Brining is necessary to give firmness to the flesh, flavor, and to conserve the appearance.

Drying

Drying is done exclusively in tunnel dryers of some form. They may be long and the fish carried on a continuous belt, or short with considerable height, the fish being carried back and forth a number of times. Baffle plates and dividers direct the current of air so as to get the maximum effect. A large dryer 3 feet wide, 8 feet high, and 75 feet long with fan, ducts, and baffle plates has a drying capacity of about 5 tons per hour. The time required in the dryer is from ¼ to 1 hour depending upon the temperature and the volume of air. The temperature should not exceed 120° F., otherwise the layer of fat beneath the skin softens and the skin splits in the frying oil.

The real object in drying is to favor toughening of the tissues and especially the skin so that the fish will not stick together nor become mushy in the can. The actual loss of moisture is not as important as the toughening effect upon the tissues. The total loss of moisture does not exceed that added in the sauce and yet adherence of the fish and more or less mushing result if this step be omitted.

Cooking in Oil

The cooking in oil has been nothing more than an extension of the oldest practice of keeping the fish whole and separate, but which in later times has been vested with the fallacy that it is for the purpose of taking out some of the natural fish oil and substituting another kind with a more pleasing flavor. The fish as they are discharged from the dryer fall into shallow wire baskets about 1½ feet wide, 3 feet long, and 4 inches deep. These baskets are conveyed through the oil heated to 230° F., the time varying from 10 to 12 minutes for the larger fish and approximately half that time for the smaller ones. The test is to take the fish by the tail and if the flesh breaks from the bones, the cooking is sufficient. These cookers are built on the same plan as the Eastern ones, but larger in size, some of them holding from 800 to 1,000 gallons or from 16 to 20 barrels of oil and capable of frying from 75 to 100 cases of fish per hour. As the oil costs from 80 to 90 cents per gallon and if used only one day, it is apparent that it becomes a costly item during a season. Clarifying, steaming, and washing effects only a partial recovery of the oil by making it suitable for other purposes. The latest development, which dates only from 1928, is the substitution of refined sardine oil for the vegetable oil. The oil is a natural by-product of the sardine and after being used for frying for only a short time, it can be recovered for uses other than edible oil and with very little loss in value. It is satisfactory for frying purposes though the flavor is somewhat different from the usual vegetable oils.

The water under the oil becomes foul and has to be drawn off and replaced at least twice a day.
The baskets are allowed to drain as they pass from the fryer and are then stacked about twelve or fifteen high on platforms which can be wheeled where wanted for cooling. They are generally allowed to stand over night.

**Filling the Cans**

The trays of fish are delivered to the filling tables where the filling of the cans is made direct from them in preference to turning them out on the table top. The large oval can is used almost exclusively for the larger fish, from four to eight making the proper fill. Those who do the filling become expert in selecting fish of the same size and close to the proper weight. Some difference in size is not as important as with the small fish, nevertheless, it is too important to the appearance to be treated indifferently. The contents must weigh slightly more than 14 ounces of fish to which 1.5 to 2 ounces of sauce, generally tomato, is added, making the total not less than 15.5 ounces. In case a souse is used on the fish, slightly more solids are packed. Oil is not used on the large fish.

The cans are conveyed away from the table to a machine which adds the sauce, preferably well heated, the cover is then clipped on, the cans exhausted and sealed. Sealing may be done in a vacuum closing machine in which event the sauce is added at a lower temperature. A three-inch vacuum is required on the finished product.

**Cooking**

The old custom of setting oval cans on edge in the cooker is best though it involves more work than simply letting them slip from the double seamer into the steaming baskets. Heating is done at 240° F. for 90 minutes or until the bones become perfectly softened, which takes longer than the time needed for sterilization. The fish are partly cooled under air pressure and water while in the retort. This reduces both leaky and distorted cans. They are then washed in an alkaline solution to remove the oil on the surface, dried, and may or may not be lacquered. The cans may be washed as they come from the closing machine.

The small fish are handled in the same manner as the Eastern sardine.

**Canning Raw Fish**

Canning of sardines by the raw pack method was made a commercial success during the season of 1929 and 1930. The preliminary steps: scalding, cutting, and brining, are the same as for the old style of packing. Machine dressing almost supersedes hand work. In one type the fish are fed upon a vibrating screen which directs them head first into a turret with pockets slightly larger than the fish and in successive steps the head is removed, the body cut to the proper length, the entrails withdrawn in such rapid succession that 300 fish are cleaned per minute.

The fish are distributed to the canning tables where the women fill them into cans by arranging them in the same manner as for cooked fish but crowded a little more closely. The fish are filled to the top of the can or slightly above and the cans conveyed away immediately to the special dryer or pre-cooker which is heated to a higher degree than the usual exhaust box. This effect may be produced in four different ways: by closed steam coils producing dry heat, by a combination of closed coils and perfo-
rated lines to spray steam against closed coils, by steam reinforced with
gas flames at the bottom of the dryer, or by a gas or oil furnace outside but
delivering the heat into the oven where it comes in direct contact with the
cans. More or less steam is admitted with the dry heat in order to prevent
surface burning of the fish. The amount of air admitted is regulated me-
chanically.

After the fish have been carried halfway through the dryer, or after
about twenty minutes, the cans are passed outside upon a mechanism which
holds a grid over the top of the can, inverts it to get rid of any moisture or
oil which may have been released from the fish, rights the can and returns
it to the oven to complete the drying. The cans are discharged through
another inverting mechanism to free them of any liquid which may have
accumulated. At the first inversion only a small amount of liquid is drained
away, at the second the quantity is two or three times as great. The fish
shrink in this treatment so that with slight pressure they will pack below
the cover line. A hot tomato or other sauce is added and the can closed at
once. Washing follows in an alkaline solution, then spraying with hot
water, and dumping into the retort cage as steps in a mechanized line.

The mechanism for doing this work has been varied by the different
packers from single line conveyors passing the cans through huge spirals
to get large capacity in small space, to the tunnel type in which ten cans
end to end and held in place by a wire holder become the unit. The cans
are carried back and forth in the oven, in the normal position in one direc-
tion and inverted in the other so that any moisture will drain away. Be-
tween each line of travel is a metal shelf to catch the drainage and also
direct the heat currents so as to get the maximum effect. The speed of travel
and the temperature can be regulated as desired. One machine of this type
is described as 60 feet in length, 10 feet in height, and 4 feet in width with
a capacity of 3,600 cans.

The California regulations require that one-pound oval cans shall be
cooked at 240° F. for 90 minutes, or 250° F. for 60 minutes.

In six years the raw pack method has almost displaced the older method
for canning the large fish. It is a much speedier and more cleanly process
in every particular and requires less hand labor. From the time the fish are
received at the factory until they are delivered in the warehouse necessi-
tates only about four hours. It eliminates all exposure to drying belts, to
questionable frying oil, any tendency to decomposition from holding in a
cooling shed from 10 to 15 hours, also any contamination due to handling
after the fish have been cooked. The advocates claim a superior product in
point of flavor but upon this point there is difference of opinion.

While the chief objective has been to cut the factory costs, this has been
accompanied by an improvement in sanitation. And, since the product
differs in many respects from the old, it might well take a new and distinc-
tive name.

Label Weights

The weights recommended to be placed on sardine labels are as follows:
No. ¼ Oil, 3¾ ozs.; No. ½ Oil, 7 ozs.; No. ¾ Mustard, 11 ozs.; No. ½
Oval, 7½ ozs., and No. 1 Oval, 15 ozs.
Composition

The sardine has a high food value as indicated by its chemical composition and is economical by comparison with other flesh food products.

<table>
<thead>
<tr>
<th>COMPOSITION OF SARDINES</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Undetermined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw fish (canning portion)</td>
<td>59.79</td>
<td>17.63</td>
<td>20.66</td>
<td>1.87</td>
<td>2.07</td>
</tr>
<tr>
<td>Canned in souse</td>
<td>59.00</td>
<td>20.38</td>
<td>15.33</td>
<td>3.22</td>
<td>1.57</td>
</tr>
<tr>
<td>Canned in tomato sauce</td>
<td>62.30</td>
<td>23.10</td>
<td>9.79</td>
<td>3.24</td>
<td>1.18</td>
</tr>
<tr>
<td>Canned in tomato sauce</td>
<td>61.25</td>
<td>20.75</td>
<td>13.08</td>
<td>3.74</td>
<td>1.57</td>
</tr>
<tr>
<td>Canned in mustard sauce</td>
<td>62.00</td>
<td>24.29</td>
<td>8.89</td>
<td>3.51</td>
<td>2.10</td>
</tr>
<tr>
<td>Packed in oil, Maine</td>
<td>46.28</td>
<td>19.88</td>
<td>30.26</td>
<td>3.24</td>
<td>1.57</td>
</tr>
<tr>
<td>Packed in oil, lean</td>
<td>43.97</td>
<td>21.44</td>
<td>31.94</td>
<td>3.74</td>
<td>1.18</td>
</tr>
<tr>
<td>Packed in oil, lean</td>
<td>44.64</td>
<td>21.81</td>
<td>27.26</td>
<td>3.51</td>
<td>2.10</td>
</tr>
</tbody>
</table>


In California and Maine all sardine canning is done under the direct supervision of their respective State Boards of Health.

F. I. D. 64. Labeling of Sardines.

Many inquiries have been made of this Department respecting the extent to which the term “sardine” can be used in food products entering into foreign or interstate commerce. The question of the proper labeling of fish of this kind was submitted by the Department of Commerce and Labor, Bureau of Fisheries. After reviewing the nomenclature and trade practices, the Department of Commerce and Labor reached the following conclusion:

“Commercially the name sardine has come to signify any small, canned, clupeoid fish, and the methods of preparation are so various that it is impossible to establish any absolute standard of quality. It appears to this Department that the purposes of the pure food law will be carried out and the public fully protected if all sardines bear labels showing the place where produced and the nature of the ingredients used in preserving or flavoring the fish.”

In harmony with the opinion of the experts of the Bureau of Fisheries, the Department of Agriculture holds that the term “sardine” may be applied to any small fish described above, and that the name “sardine” should be accompanied with the name of the country or state in which the fish are taken and prepared, and with a statement of the nature of the ingredients used in preserving or flavoring the fish.

It is held that a small fish of the clupeoid family, caught upon or near the shores of and packed in oil in Norway, or smoked and packed in oil, is properly labeled with the phrase “Norwegian Sardines in Oil,” or “Norwegian Smoked Sardines in Oil,” the nature of the oil being designated. In like manner a small fish of the clupeoid family caught on or near the shores of and packed in the United States may be labeled “American Sardines Packed in Oil,” or “Maine Sardines Packed in Oil,” or be given some similar appellation, the nature of the oil being stated. It is suggested that the name of the particular fish to which the term sardine is to be applied should also be placed upon the label—for example, “Pilchard,” “Herring,” etc.

By-products

The waste from the preparation of sardines is pressed and dried as a source of oil and as material for feed and fertilizer. As both of these products are particularly rich in vitamins, they are finding a new use in poultry and stock feed, especially for the young. Where formerly the meal was used almost exclusively for fertilizer, the present manufacture is carried out very much more carefully and the product sold for mixing in feeds.
It requires about 5½ tons of raw fish to produce 1 ton of meal, and 1 ton of fish will yield from 20 to 50 gallons of oil.

Patents

The direction in which attempts have been made to lessen the work and improve the packing of sardines are indicated in the following patents:

Taylor Patents

Patent No. 1,016,046, January 30, 1912, issued to W. E. Taylor, Eastport, Maine, sets forth his method. "In practicing my improved process, I take the freshly caught fish and pickle them in strong brine for about an hour and one-half, which is the usual procedure. The pickled fish are then placed in a close chamber into which live steam is turned directly among the fish which are spread out upon suitable racks in the ordinary manner. The fish are steamed until the flesh breaks away readily from the bone. After such steaming the fish are placed in a draft of air and thoroughly dried until they become stiff and hard. The fish thus dried are now placed in the open cans which are filled up with oil surrounding the fish.

The open cans containing the fish and oil are now placed in an oven where they are subjected to a heat exceeding 212° F. I prefer a temperature of about 220° or 225°, though this may be considerably exceeded, if it is desired to tinge or darken the oil. These cans filled with the sardines and the oil are left in the oven under the temperature stated for about one hour and one-half or two hours, by which they are thoroughly heated through and have acquired an improved flavor. A cover is now applied to the can while the same is still hot and hermetically sealed by a well known means. The sardines so sealed will keep indefinitely; will have a fine flavor; the bones will be soft; and the interior of the can when cold will be firm and not swelled. This method of putting up sardines by subjecting them to dry oven heat and thus killing all germs before sealing, obviates the necessity of subjecting the sealed cans to the process bath after sealing, and leaves the product in better shape.

A modification of the process is contained in Patent No. 1,250,384, December 18, 1917, by the same inventor.

The fresh fish having been pickled in salt brine and dried in any suitable manner, which is a common procedure which may be followed, are or may be packed dry in open cans in which they are sealed and preserved. The fish so packed are then brought in contact with heated oil in such manner that the fish are properly fried and cooked, for which purpose said oil is or may be at the boiling point. This cooking causes a certain amount of water or fluid to pass by osmosis out of the fish and collect in the bottom of the cans beneath the oil, and this water I remove in any suitable manner before sealing the cans, as it might otherwise cause the spoiling or deterioration of the fish or their flavor. The steps of packing and cooking in oil in the preserving cans may be carried out as described in my patent. Preferably the cans, filled with fish and oil, are held in or passed through a body of boiling oil so as to be immersed for a suitable length of time for the frying and cooking of the fish, which time may depend upon the size of the fish and temperature of the cooking oil; about four minutes being ordinarily sufficient. Before the cans are removed from the heated oil, they are tilted sufficiently to pour out the collected water, which will sink to the bottom of the body of oil, and is replaced by oil from the said body which enters the cans. The cans are then reverted and are removed from said body of oil, each can remaining filled, or substantially filled, with the heated oil. The cans are then hermetically closed and sealed.

The removing of the water should take place at or about the end of the cooking process, or at any time when no more water will pass out from the fish.

In practicing the process according to said preferred manner, the packed cans may be handled by a conveyor passing continuously through a vat of heated oil, with provision for suitable means for tilting the cans and for retaining the fish within the cans.

Results of this process are that the fish are well cooked, have a fine flavor, are not broken up or injured, all germs are destroyed and the fish will not spoil or deteriorate; and the process is simple, inexpensive and rapid, no processing being required after the sealing of the cans, other than such sterilization as may be necessary to destroy germs or bacteria which might get into the tops of the cans in the interval between passing of the cans from the oil and the sealing of the covers. But the invention does not exclude such processing if it be desired to perform it. A preliminary drying of the fish is not necessary to the process herein claimed.
Patent No. 1,330,055, February 10, 1920, issued to H. L. Bryant of Princeton, and O. E. Stinchfield of Covina, Maine, is for a can holding device and also a grid cover to retain the fish in the can when the same is cooked by the method previously described.

Patent No. 1,604,402, October 26, 1926, issued to P. W. Fleischer, Weehawken, New Jersey, is for a device for turning cans over and draining in connection with the cooker already described.

Patents Nos. Re. 1,037, August 27, 1912, and 1,170,762, February 8, 1916, issued to D. M. Lawrence, Lubec, Maine, sets forth the following:

**Lawrence Patent**

My process may be described as follows: The fish direct from the drier, uncooked, are packed in the permanent containers and are then conveyed uncovered to a machine that supplies them with a measured quantity of oil. The cans still uncovered, are conveyed over artificial heat at a comparatively slow rate for a time long enough to thoroughly fry the fish. After which they are transferred to the covering and sealing machine.

My present invention obviates all the objections to the old process. Here, there is no loss by breakage in handling, there is no loss of oil, no discoloration or fouling of the fish in frying, no personal contact with the fish after they are cooked, and there is greater uniformity in the fish, due to the fact that each can contains a uniform quantity of oil.

The addition in the second patent is: My improved process consists in packing the raw fish in open cans, covering the open tops of the cans with screens to prevent them from dropping out, inverting the cans of fish thus protected, subjecting the fish in the inverted cans to heat, steam or hot air, until the fish are thoroughly sterilized and cooked, allowing them to remain in such inverted position until the water drains out and frying them in hot oil.

It is noted that the fish may be packed in cans before or after they have been eviscerated and decapitated, that any convenient method of holding or transporting the cans and applying the screens to them may be employed, that any desired means of applying heat to the inverted cans may be employed, such, for example, as conveying them through a steam retort or hot oven and that any convenient or suitable method of frying the fish in oil may be employed.

The objectives of these patents were excellent, but the results hoped for were not completely attained and little use was made of them. The matter was again revived in the packing of raw sardines on the West Coast, beginning in 1920, but not brought to a commercial fulfillment until 1930.

Patent No. 1,335,136, March 30, 1920, issued to M. H. Stuart, Santa Cruz, California, is for a cooker and dryer employing a different mechanism for turning over the open can in order to drain the liquid which separates as a result of heating the fish. Raw fish are packed in the can, which is then placed in special receptacles that are made part of the conveyor system passing through the heater and dryer. These can pockets have screen tops to hold the fish in the can. After heating for a certain time the can is inverted to drain any moisture which may have separated. Drying takes place in the inverted can and, when this is completed, the can is restored to its normal position and discharged upon a conveyor leading to the machine for adding the oil and sealing, after which the cooking is done in the usual manner.

Patent No. 1,677,364, July 17, 1918, issued to D. D. Peebles, Eureka, California, provides that the dressed fish be placed in the can, carried on a conveyor under a strong blast of hot air to cause drying and shrinking, then under a series of electric units to gradually reheat and then broil the fish by radiant heat, and finally under a refrigerating coil to receive a blast of cold air, after which the cans receive oil or sauce and are sealed and cooked as usual.
The spiny sea crayfish, caught in California waters and off the Lower California coast, is handled essentially the same as the lobster, and for a time was marketed as lobster. These crustaceans are larger than the lobster, and similar in appearance except for the absence of the very heavy claws. They have a dark color when taken from the water, but become bright red upon boiling. The flesh is much tougher than the lobster and not so sweet.

S. R. A. No. 103. The Labeling of Canned Crawfish.

The attention of the Bureau has been called to a canned product which is actually a species of crawfish (Panulirus interruptus), and is variously labeled as “spiny lobster,” “rock lobster,” “Cape lobster,” “Pacific lobster,” or “crawfish.” It is the opinion of the Bureau that the term “lobster” either unqualified or when accompanied by a geographical name such as “Cape” or “Pacific,” “spiny lobster,” or “rock lobster,” but in this case the qualifying words should be given in direct connection with the word “lobster,” and in type of equal size and prominence. The term “lobster,” without qualification, is applicable only to the true lobster (Homarus). Labels showing pictures of the true lobster on canned crawfish are also regarded as false and misleading.

SHRIMP

Palaemon serratus

Shrimp canning represents one of the important fishing industries and until a few years ago it ranged third in value, the salmon and oyster being first and second respectively. Its position has been changed, the salmon, California sardine, Maine sardine, and tuna being ahead, and the oyster dropped behind. The catch of shrimp has not kept pace with some of the other fisheries and the supply for canning has been decreased because of the greater demand for the fresh market at prices above that at which it is profitable to can them.

The shrimp is a salt water crustacean resembling the fresh water crayfish. Those occurring in the Gulf and southern Atlantic waters are generally from five to seven inches long, of a bluish-gray color and having a semi-translucent effect. Though delicate and easily crushed, they are strong rapid swimmers while in their native habitat. The very large specimens are frequently called prawns but that designation is most often applied to the large shrimp exported to England and Europe. The ichthyologists have come to the rescue of this old trade practice and state that there are two species instead of one, that the larger one used for canning as shrimp is Palaemon serratus or prawn, and the other Crangon vulgaris, the shrimp proper but of smaller size. Only part of the life history of these interesting creatures is known, and of the larger form only the period when it comes from the deep water to the shoals along the coast.

The shrimp has a well developed abdomen and tail which together furnish a delicious morsel of meat differing from both the lobster and crab. The raw peeled portion is flabby and grayish until boiled, when it becomes clear white with pink and red markings upon the outside, very firm and rather dry. It is a delicacy used chiefly in salads and so-called cocktails or to impart flavor to gumbos or other dishes.
Distribution

The principal distribution of the shrimp is from Savannah, Georgia, south to the St. Johns River, and from Florida to Mexico in the Gulf; Biloxi, Mississippi, and Barataria Bay, Louisiana, are the principal fishing points in that sector. The principal shore runs occur from February to April in the spring and from September to November in the fall though some are found at other times. The runs in the Atlantic occur a few weeks later than in the Gulf. Shrimp are found at other points but are of such small size as not to be of value in canning. A large species also occurs on the west coast of Mexico.

The delicacy of this food was recognized by the people living along the seashore, but owing to the fact that the catching was done in warm weather with consequent quick spoilage and there was no means for marketing them, they remained unknown to others. A few Orientals caught and dried them according to the custom in their country, but the quantity was negligible.

G. W. Dunbar of New Orleans, began experimenting with canning shrimp in 1867 but was not really successful until 1875. The shrimp contain bodies which liberate sulphur compounds upon heating and which combine with the iron of the can to form black iron sulphide, causing black or bluish spots on the shrimp and a precipitate in the brine giving a dirty appearance, as well as affecting the flavor. As a result of many attempts during the eight years, he found that by enclosing the shrimp in a cloth bag inside the can that most of the difficulty could be overcome. On June 20, 1876, he received a patent for this improvement, and a re-issue December 6, 1881. A few paragraphs from the latter are descriptive and interesting because they mark the first attempt to correct a difficulty which has been the subject of a large amount of costly research.

Dunbar Patent

The object of our present invention is to provide an improved method of preserving shrimps or prawns, and, indeed, all kinds of shell-fish, preventing their discoloration and insuring the retention of their original freshness and flavor.

In canning the shrimps or prawns, we have found that direct contact of the shrimps with the can and the presence of free liquid or gravy in the shrimps, after they are placed in the can, are very objectionable for the following reasons:

First. The direct contact of the shrimps with the can causes, during the process of cooking and thereafter, a precipitation of black or dark matter which discolors the shrimps and detracts from their flavor and richness. This precipitation is believed to be caused by the action of sulphur compounds contained in the shrimps on the metal of the can.

Second. Free liquid or gravy in the shrimps constitute a vehicle or medium to diffuse the dark precipitate or coloring matter throughout the entire mass of shrimps in the can, so that all portions of the contents of the can are equally affected and discolored.

Our invention has for its object to obviate the above named objections; and it consists in first providing the can with a lining to prevent direct contact of the shrimps with the metal, and second, placing the shrimps in the lined can while they are in a dry or moist condition and devoid of free liquid or gravy, sealing the can without adding any liquid to the contents, and cooking the contents of the can after sealing, all of which we will now proceed to describe.

In canning the shrimps we employ the following process: The shell having been removed from the shrimp in the usual manner, the fish is thrown into salt water of about 6°, and there remains for an hour (more or less), and from thence to kettles filled with water and brought to a boiling heat, after which they are placed on drippers and cooled and thoroughly rinsed with fresh cold water, from which, so soon as thor-
oughly dripped and in a moist condition, and without the addition of any salt or otherwise prepared liquid, they are placed in the sack \textit{B}, the same having been previously arranged in the can \textit{A}. So soon as the sack is filled, the mouth thereof being properly secured, the lid or head \textit{a} is placed in position on the can \textit{A}, and immediately sealed. The cans are then subjected to a steam bath, or placed in kettles containing boiling water, and boiled for two hours at the highest temperature attainable, and which completes the process.

Others were quick to utilize the suggestion but made modifications in carrying it out to evade the patent. In 1879, a shrimp cannery was established in Galveston, Texas, and in order to prevent the usual discoloration, the cans were treated with asphaltum and then lined with paper which had been dipped in paraffin. A patent upon the liner was obtained in 1880. The asphaltum ingredient was dropped at once but the paper portion was retained, being further modified as “vegetable parchment” and used almost exclusively until 1926. It was the easiest material to apply, and proved better than other materials. The patent also disclosed that cans were treated on the inside with copal varnish so that inside lacquering is not a recent process.

Very thin veneer-cut wood was used by some as a liner and continued in use until about 1912. A unique liner consisting of selected corn husks was the invention of Louis Length, St. Louis, Missouri. The inside lacquered can was used as soon as it came out but was not satisfactory though the latest kind, C-enamel has met all objections and is almost universally used and with or without the paper liner. From the inception of the industry, the greatest difficulty has been with the cans, from discoloration and pinholing.

Glass makes an ideal container for shrimp and has the advantage of displaying the product. The pack can be made very attractive by a little attention to the arrangement of the pieces.

The importance of the canned shrimp industry is not fully expressed by saying that the annual output is worth about $5,000,000 as with some other foods for the canning gives employment to a large number of persons before and after the oyster season when they would have difficulty in finding other employment.

**Catching**

The canning of shrimp made it necessary to catch them in larger quantities by comparison with that necessary to supply the fresh market. The most primitive method was to row over the shallow flats and use a cast net, which is a circular net about seven or eight feet in diameter with light lead weight at close intervals around the edge, is thrown full flat and when it has rested on the bottom is drawn in by the cord attached at its center. This sufficed when one or two tubfuls were wanted and the shrimp were abundant. Moreover, such a meager equipment limited the work to the immediate vicinity of the factory.

The next step was the use of a long seine about one fathom in width, and to use an oyster schooner in hauling it to the flats. These seines gradually were increased in length until they became fairly well standardized at from 150 to 225 fathoms (900 to 1,350 feet). This was as much as could be handled in a tender such as was necessary in the shallow waters and to get to the shore. The shrimps were located with the cast net, then the seine
trolled out, one end at the shore and the other carried out and around to enclose as large an area as possible. When the second end was carried ashore, the two ends were drawn together, care being taken to keep the lower edge on the ground for if an opening occurred the shrimp were sure to escape. The depth of the seine made it necessary to work in water which admitted of wading. As the seine was drawn from the two ends the shrimp were forced into the bag from which they were dipped out into the tender or aboard the vessel. They were put into the hold as quickly as possible for protection. Ice was not available at first but came later. Without ice, the catch had to be landed as soon as the wind would permit. The advent of artificial ice made possible cruising to longer distances and holding the catch for a few days. The next improvement came when several small vessels working in the same locality combined their catches if small, and one boat carried them in without delay. This was the method followed until 1914.

A further improvement followed in the use of longer and wider seines, permitting work in water up to ten feet or even more in depth. The seines were made from 140 to 170 meshes in width (105 to 126 inches), and were provided with a lead line at the bottom and cork floats at the top. A stake with a pulley at the bottom was driven into the ground and a rope arranged so that the lower part of the seine could be drawn in at the same time as the top, the weights keeping it on the ground. The seine was thrown out in a large circle and the patent gear manipulated from the larger vessel. The manipulation in other respects was essentially the same as for the smaller seine. The advantage of this apparatus was chiefly in being able to take the shrimp in deeper water when they were not running close to the shore. The gear was invented in 1911 and is still in use.

The next forward step was the motorizing of the boats, thus making the trips to and from the grounds independent of the wind and insuring fresh material being delivered at the factory. The oyster and shrimp boats have a capacity of from 140 to 160 barrels for the average size and up to 400 barrels for the large ones.

The latest development in the catching came in 1920 with the introduction of the otter trawler. A power boat about one-half the size of the schooner is used for this purpose. Two or three men constitute a crew. The catching device consists of a trawl net having a lead line below and a cork line above, with plank or heavy board sides about 20 inches wide and 6 feet long. These are so fastened in the mouth of the net that the tow lines attached to them tend to keep the mouth wide open and to direct the back ends of the boards inward. The opening of the bag is about 25 feet wide and 20 inches in height though some are made much larger. At the rear end of the bag is a line buoy to show its position. The mesh used in the bag allows the small shrimp to escape but retains the large ones.

The trawl is pulled along on the bottom and raised every half hour or other interval found desirable. The contents are dumped on the deck and picked over for other fish before dropping them into the hold. The dragging is done slowly to prevent tearing the net and the hoisting done by power from the boat so that a small crew can handle the outfit. This fishing gear makes the work more nearly independent of the weather and to be done in deeper water than by either of the other methods.
Factory Operations

When fresh shrimp are delivered at the factory, they are weighed, or checked by the barrel which is accepted as 200 pounds. They are washed, and the soft and injured ones culled out and the good ones put in the refrigerator with crushed ice to be held over night. If the shrimp have been iced on the boat for more than three hours, the head and thorax are broken off, and the tail portion packed in ice until the following day before squeezing out the meat. If they have been in ice over night or longer, they are washed, weighed, headed, and peeled ready for the successive steps in canning. It is necessary to have the shrimp thoroughly chilled in order to have the muscular portion of the abdomen and tail come away from the shell without tearing or mashing, and when in good condition, this work can be done very rapidly.

A further reason for thorough chilling is that the shrimp contain an active digestive principle which attacks the skin of the hands and this activity is inhibited by cold.

Washing

The washing is done by floating the shrimp through a trough under sprays of water. As they emerge on the conveyor, they may be transferred to another which carries them directly to the picking tables or they may be discharged into enamel pans and distributed to the tables. For small factories and where the work is irregular the pan system is the better. It affords the maximum protection to the shrimp and the pans can be cleaned more easily than a belt. It also gives an opportunity to check the losses from poor workmanship. The shrimp are picked out of one pan, the peeled material placed in another, and the waste delivered in a trough for fertilizer. The peeling is usually done as piece work and paid for by the pound.

Parboiling

After the peeled shrimp are washed in a tank of water, they are ready for parboiling. This operation is conducted in tanks which are fairly deep in order to reduce the surface exposure. They are nearly filled with brine and heated directly by steam through a perforated cross at the bottom. Salt is ordinarily present at the rate of about three-quarters of a pound to the gallon of water but this may vary from as low as one-half to as high as one pound to the gallon. No data seem to be available concerning the effect of varying percentages of salt upon the quality of the shrimp, the amount being left to the judgment of the superintendent. The shrimp are put into wire baskets in lots not to exceed 25 pounds so that the whole will be heated uniformly and quickly. The volume of brine is such that the introduction of the cold meat produces only a temporary interruption in the boiling, which begins in about one minute. The precook for wet packed shrimp is about 4 minutes, and for dry packed shrimp from 6 to 9 minutes. In order to get a smooth surface and the minimum of crumbling, the heating can be done in two stages, the first minute at about 150° to 160° F., then in boiling water. Turning the cold shrimp directly into boiling water loosens the surface causing it to become slightly fluffy due to the sudden change in temperature. Continuous parboilers are used but unless handled very gently and without overtaxing its capacity there is roughening of the surface and more or less breakage of the bodies.
The cooked shrimp are turned out on drying frames about four feet wide and ten feet long having quarter-inch wire for a bottom. The object is to get quick drainage and cooling as the heat of the shrimp carries off the free moisture from the surface. In some of the large factories the shrimp are turned onto slow moving wire mesh belts which carry them directly over the filling tables and the filling of the cans is done from the belts. If the shrimp be filled into cans before they dry upon the surface, they mat or stick together to some degree. In order to prevent this, dry pack shrimp are boiled longer in the brine and dried somewhat more than the wet pack shrimp.

**Filling**

The filling of the cans is by hand and must be checked by weight to be certain they cut out not less than 5½ ounces drained solids for the No. 1 can, wet pack, or 5 ounces for dry pack; and 9¾ ounces for No. 1½ can wet pack. 8¼ ounces for the dry pack. These weights appear rather slack at the time of packing but any over-filling causes matting and a poor appearance. Too little brine in a wet pack permits some gelatinizing. The wet pack brine contains 1 per cent of salt. In both styles the cans should be well exhausted either by heating or in a vacuum sealer. C-enamel cans are preferred to prevent blackening.

Packing in glass has shown some increase since 1924 and the nature of the product warrants a larger proportion being thus prepared. For the 8 ounce tumbler, 5¾ ounces of shrimp and for the 9 ounce tumbler, 6¾ ounces of shrimp seems to be about right.

**Cooking**

The wet pack shrimp is cooked at 240° F. for 12 minutes for the No. 1 can and 15 minutes for the No. 1½ can. The dry pack shrimp is given the same temperature, but 75 and 85 minutes respectively for the No. 1 and No. 1½ if a liner be used. If time permits, the dry shrimp may be processed at boiling but for four hours. The shrimp are not so dry and tough and have a better flavor. Cooling should follow immediately after the cooking to avoid all handling while they are warm. The cooking in glass requires about 15 minutes to raise the retort temperature to 240° F., it is held for 18 minutes, and requires about 20 minutes to cool to a point where the retort may be opened.

A barrel of shrimp will yield about 175 cans of the No. 1 size or 90 cans of the No. 1½ size.

**Label Weights**

Dry pack: Picnic, No. 1 East, 5 ozs.; Squat, 5 ozs.; No. 1½, 8 ozs.
Wet pack: Picnic, No. 1 East, 5¾ ozs.; Squat, 5 ozs.; No. 1½, 9¾ ozs.
(Drained weight.)

**Composition**

The composition of shrimp as given by E. D. Clark and L. McNaughton, in “Shrimp: Handling, Transportation, and Uses,” United States Bureau of Chemistry Bulletin No. 538 is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Protein</th>
<th>Carbohydrates</th>
<th>Fat</th>
<th>Water</th>
<th>Salt</th>
<th>Calories Per Pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked</td>
<td>27.6%</td>
<td></td>
<td>1.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned, dry packed</td>
<td>25.5</td>
<td>00</td>
<td>.8</td>
<td>64.5%</td>
<td>4.8%</td>
<td>559</td>
</tr>
<tr>
<td>Canned, wet packed</td>
<td>20.0</td>
<td>00</td>
<td>.5</td>
<td>75.7</td>
<td>1.9</td>
<td>395</td>
</tr>
</tbody>
</table>
By-product

The waste from shrimp makes an excellent fertilizer, easily prepared by drying and grinding.

S. R. A. No. 297. Weights of Shrimp in Cans of Various Sizes.

After consideration of what constitutes proper fill in case of canned shrimp, the Bureau is of the opinion that canned shrimp properly packed should contain no less than the following "cut-out" weights of shrimp.

<table>
<thead>
<tr>
<th>Size of can No.</th>
<th>Diameter</th>
<th>Height</th>
<th>&quot;Cut-out&quot; Weight of Shrimp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry pack shrimp</td>
<td>1</td>
<td>2½</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1½ Sanitary</td>
<td>3½</td>
<td>3½</td>
</tr>
<tr>
<td></td>
<td>Hole and cap</td>
<td>3½</td>
<td></td>
</tr>
<tr>
<td>Wet pack shrimp</td>
<td>1</td>
<td>2½</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1½ Sanitary</td>
<td>3½</td>
<td>3½</td>
</tr>
<tr>
<td></td>
<td>Hole and cap</td>
<td>3½</td>
<td></td>
</tr>
</tbody>
</table>

The procedure adopted for draining off the liquid is the same as that described in S. R. A. Chem. 14, item 134:

"Make a circular cut almost around the top of the can, push the cut top back into its original position, invert, and allow the contents to drain through the circular opening for one minute. Pour the liquid through a colander and return to the can any weighable particles of solids which have been carried away by the liquid. The openings in the colander should not exceed ¼ inch in diameter."

In connection with the canning of shrimp, attention is directed to the requirements of Food Inspection Decision 144, that cans should be as full of food as practicable for packing and processing without injuring the quality or appearance of the contents. In the case of food packed with water, brine, etc., the cans should be as full as possible of food and should contain only sufficient liquor to fill the interstices and cover the product.

The weights indicated above have been obtained by the Bureau after examination of experimental packs of canned shrimp which have been put up on connection with the study of Food Inspection Decision 144.


It has come to the attention of the Bureau that some packers of shrimp are labeling their product "Barataria shrimp" regardless of whether or not the shrimp so labeled are caught in Barataria Bay. Paragraph (b) of regulation 19 of the Rules and Regulations for the enforcement of the Federal Food and Drugs Act is as follows:

"The use of a geographical name shall not be permitted in connection with a food or drug product not manufactured or produced in that place, when such name indicates that the article was manufactured or produced in that place."

It is the opinion of the Bureau that the term "Barataria" should be applied only to the shrimp caught in Barataria Bay. The use of this term in labeling shrimp caught at other places is deemed misbranding under the terms of the Federal Food and Drugs Act.

TUNA

The tuna is one of the oldest known commercial fish. Accounts are given of it from very early times, showing it to have been held in high esteem for great feasts as well as for the necessities of the poor. Centuries later it became an important item during Lent. The catching of the fish in the Mediterranean Sea was such a strenuous occupation as to fit sailors for the merchant fleet and for long voyages in exploration. It was looked upon much the same as cod fishing out of Gloucester before the advent of the steam trawler.
Until less than thirty years ago the tuna on the West Coast had little or no commercial importance other than to attract a few sportmen for the sheer pleasure of capturing a fish. The albacore, a species of tuna, is a particularly gamey fish, difficult to hook and much more difficult to land. At first the flesh was considered to be too strong for the fresh food market but through the work of A. P. Halfhill of San Pedro, California, it became one of the choicest of the canned fish. This came about as a result of a shortage in the sardine catch during a couple of seasons, and in order to keep the factory from a complete shutdown, he began experimenting in the preparation and canning of the tuna in 1907. After many trials he was rewarded with success though only about 250 cases were distributed that year. The millions of cases packed since that time following essentially the same method, though many others have been tried, is a tribute to his skill. It is a curious fact that this represents a reversal of the conditions in the Mediterranean when the fishermen first developed the sardine industry as a result of poor catches of tuna.

The Fish

The tunas belong to the mackerel family, the four or five species being so closely related and having so many characteristics in common that they are collectively known as tuna. The first species used in canning was the Albacore or Longfin tuna (Thunnus alalunga, Gerino germo, or Gerino alalunga) because of its size and white meat. This fish looks like a mackerel and is distinguished by its long fins. It is a beautiful fish weighing from 10 to 50 pounds with an average of 20 pounds. It is remarkably gamey and speedy, caught only at the surface with hook and line. Its habits and behavior are directly opposite to those of the salmon. It has a higher proportion of white meat, which in this case is of very fine texture and more delicate flavor than the other species of tuna. It appeared to be abundant at first off the coast of San Pedro and southward, but that may have been due in part to the relatively few used in the small early packs. The number was quickly depleted and from 1925 to 1934 a large specimen was uncommon. Towards the end of that year albacore began to return and have been fairly plentiful. The apparent depletion may have been only a cycle in its migration.

The Yellowfin (Germo mactopterus) has become the principal source of canned tuna. It resembles the albacore though its pectoral fins are less than half as long. It inhabits the waters from north of Catalina Islands south to Central America, and is also found in the South Seas. In size, it ranges from 10 to 200 pounds, the average being about 40 pounds. The flesh has a much higher percentage of dark meat than the albacore and with the light portions showing considerable variation in color, from almost white as in the albacore through pinkish and yellowish to a distinctly dark shade. The texture and flavor are good. By careful selection a large proportion can be marketed as light meat tuna.

The Bluefin or Leaping Tuna (Thunnus thynnus, or Thunnus satiens) is the one supposed to be identical with the "Tunny" of the Mediterranean and from which the group was named. This is another large fish, frequently attaining a weight of 200 to 250 pounds, though the average commercial catch is more nearly 40 to 50 pounds. It is one of the gamiest fishes, like the tarpon of Florida waters, but one which is taken in purse seines.
in commercial catching. The quantity available is small. The flesh is similar to the yellowfin though the texture is not equal to the latter.

The Striped Tuna or Skipjack (Gymnosarda pelamis, or Entynnus pelamis) is a small fish averaging only about 8 pounds with a maximum of 20 pounds. It is distinguished by an almost total lack of scales or rather they are inconspicuous and partly covered by a growth from the skin so that they escape attention. This is sufficiently characteristic of the tuna group that many Jews do not consider them Kosher. It inhabits the same waters as the yellowfin, and is of almost equal importance to the packer. It is caught only by hook and line except in one locality. The flesh is of a darker color than the others and for that reason brings a lower price with the added handicap that it cannot be cut into solid pieces as in other species. The flesh has a good texture and a gamey flavor.

A considerable part of this is packed in "Tonno" style, the pieces packed with olive oil instead of cottonseed oil and with a double allowance of salt. Other spices may also be added. This is the style preferred by the people from southern Europe who are the best customers for this fish.

Two other fishes caught at the same time and packed in the same manner, though not permitted to carry "tuna" on the label, are Yellowtail (Seriola dorsalis) and Bonito (Sarda chilensis).

**Development in Packing**

At the beginning of the packing, the fish were caught near San Pedro during the summer, the maximum catch being in July and August. As the demand increased and more packers engaged in the business, the fishing was extended from off the coast of Lower California to Monterey Bay, and the time of catching lengthened from June to November. Since 1927, the fishing has ceased to be seasonal as large power vessels are fitted to go to the fishing grounds far south to Central America and at any time. They are provided with the finest fishing equipment, live bait tanks, and refrigeration to handle the cargo. The development in the means of catching and of transporting them has been second to none in the fishing industry. This is reflected in the statistics. The packs for the years 1907 to 1911 include only those made by Mr. Halfhill. In 1912, his pack amounted to 12,000 cases but several others started at that time and are included in the total.

<table>
<thead>
<tr>
<th>Year</th>
<th>Pack</th>
<th>Year</th>
<th>Pack</th>
<th>Year</th>
<th>Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>1907</td>
<td>207</td>
<td>1917</td>
<td>683,540</td>
<td>1927</td>
<td>1,227,013</td>
</tr>
<tr>
<td>1908</td>
<td>600</td>
<td>1918</td>
<td>521,353</td>
<td>1928</td>
<td>1,210,363</td>
</tr>
<tr>
<td>1909</td>
<td>3,000</td>
<td>1919</td>
<td>831,962</td>
<td>1929</td>
<td>1,441,044</td>
</tr>
<tr>
<td>1910</td>
<td>6,600</td>
<td>1920</td>
<td>838,802</td>
<td>1930</td>
<td>1,920,389</td>
</tr>
<tr>
<td>1911</td>
<td>10,000</td>
<td>1921</td>
<td>838,678</td>
<td>1931</td>
<td>1,145,413</td>
</tr>
<tr>
<td>1912</td>
<td>75,900</td>
<td>1922</td>
<td>661,521</td>
<td>1932</td>
<td>1,161,151</td>
</tr>
<tr>
<td>1913</td>
<td>77,500</td>
<td>1923</td>
<td>856,779</td>
<td>1933</td>
<td>1,389,450</td>
</tr>
<tr>
<td>1914</td>
<td>217,000</td>
<td>1924</td>
<td>672,300</td>
<td>1934</td>
<td>1,872,507</td>
</tr>
<tr>
<td>1915</td>
<td>237,365</td>
<td>1925</td>
<td>1,093,363</td>
<td>1935</td>
<td>2,476,648</td>
</tr>
<tr>
<td>1916</td>
<td>489,830</td>
<td>1926</td>
<td>839,059</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The only limit in packing has been the amount of fish that could be caught though it has been apparent that the quantity has more than met the market demands at times. Iced tuna is also brought in from Japan and the Hawaiian Islands and canned at San Pedro.

The price of the fish has increased in keeping with the demand. The price for albacore at first was from $20 to $25 per ton. As these became less plen-
tiful, the price on other species went up and at the time of the war was raised to $37 per ton, and instead of declining after hostilities were over, as occurred with most articles, the price continued to climb, bringing as much as $80 to $100 per ton. Albacore advanced to $300, but as no fish of this species were available, the price was immaterial. On the return of the fish in 1935, the price was set at $150 per ton. At this figure, the meat in a one-pound can costs about 45 cents and must necessarily bring a high retail price.

**Fishing**

The catching of tuna is an art in itself, one in which there has been continuous evolution during the past twenty years, as is evidenced by the enormous increase in the pack and without a proportionate increase in the number of fishermen. The albacore and striped tuna can be taken only with hook and line, only one line to a man and often require two and sometimes three men to land one fish. The yellowfin and bluefin are taken with purse seines; also some bonito.

Tuna do not run in schools like mackerel at the surface of the water but at a distance of ten feet or more below. They can be located only by trial; that is, throwing out bait at intervals. When fish are located, they are lured with live bait, such as sardines, thrown on the water and on hooks. The fish are voracious in going after food, but are also wary and easily scared away, fleeing into deep water.

When the fish is brought on board, it is struck on the head to kill it and prevent threshing about on the deck or bruising itself. As the fish is red blooded, it would seem logical to cut the throat at once so as to expel the blood through contraction of the muscles before coagulation takes place.

As soon as the active fishing stops, or sooner if necessary, the fish are placed in the hold with an ample quantity of ice to keep them in good condition. Formerly, the fish were dressed on the trip to the factory, but probably, as in the case of poultry, less infection of the body takes place from the undisturbed viscera than from opening the abdomen and tissues. Decapitation and evisceration take place only in the factory under present practices. Care is exercised in icing and refrigerating to bring the fish to the freezing point but not to freeze the mass solid.

**Unloading**

Unloading is accomplished by drawing the boat alongside a conveyor which has a receiving boot that rises and falls with the tide. The usual type of conveyor is a chain with wooden crossbars about thirty inches apart. The fish are lifted out of the hold in baskets, if they be small, or by roping around the tail if they be large. Water may be sprayed on the fish while on the conveyor. They are distributed to inclined tables, or by chutes to the floor.

**Factory Operations**

The preparatory steps consist in dropping the fish into a tank to rinse the outside, drawing on the butchering table, decapitating, removing the viscera, and dropping into another tank to wash out the blood. Formerly the fish were hung by the tail to drain the blood, but with the handling of large numbers that has been dispensed with.
The loss from heads is about 13 per cent in weight, and from the viscera about 4.5 per cent, making a total loss of 17.5 per cent in the butchering. This proportion seems to hold fairly close irrespective of the size of the fish.

The fish are next placed in shallow wire baskets or trays which need to be done with care to insure that they are straight, for if not, there will be unnecessary loss in cutting for the cans. The straighter they are, the better the appearance of the cuts. These baskets are about 20 inches wide, 30 inches long, and 5 inches deep. They are loaded into special racks mounted on wheels so that they can be run into the steam boxes and afterward into the cooling room. The steam boxes are made of heavy sheet metal with closely fitting doors but do not have to stand pressure so that the temperature attained in cooking is from 212° to a possible 218° F., obtained in part by radiation from closed coils. Heating to only 212° or below results in a soggy condition of the fish. The time of steaming is from 2 to 6 hours, depending upon the size of the fish, or until the flesh is thoroughly cooked and separates from the bone. The skin cracks and can be separated in large pieces. The oil and a good deal of the moisture is cooked out and with it an almost complete elimination of the strong fishy smell. This pre-steaming is the distinctive treatment developed by Mr. Halfhill. It has the effect of making canned tuna very different from the fresh or any other treated fish.

When steaming is completed the racks are wheeled into a room to cool, usually overnight or from 12 to 16 hours.

The loss from cooking, that is, from oil and moisture cooked out, is also about 17.5 per cent, varying somewhat with the amount of cooking. In the desire to avoid loss, some fish are not cooked as dry as others but the figures given are believed to fairly represent a well cooked fish.

The rapidity with which the steaming is brought up depends upon the size of the fish; for small fish, those weighing less than 20 pounds, 20 minutes are allowed to bring the temperature in the box up to 214°; for medium size, 25 to 75 pounds, 30 minutes; and for larger fish, from 45 to 60 minutes. Too rapid heating breaks the skin and injures the tissues and this is particularly true for that which has been iced. The pre-cooking schedule based upon the size is approximately as follows: fish weighing from 10 to 20 pounds, 3½ hours; 40 pounds, 5 hours; 75 pounds, 7 hours; 100 pounds, 10 hours; 150 pounds, 13 hours; and 200 pounds, 18 hours. For this reason it is necessary to sort fish for size and segregate the lots in the cookers.

Separating the Meat

The trays or baskets are taken to the preparation tables where the skin and fins are first removed and the flesh broken apart along the backbone. The bones are lifted out in one piece, and the dark meat on either side is separated from the light meat. The halves of light meat are laid upon the cutting boards and are then ready to go to the cutting machines. The boards with the fish are slipped under the cutting press, which in this case consists of a series of thin knives held in a frame, the whole being operated by a lever. The knives make transverse cuts spaced to correspond with the height of the can being used.

The smaller scraps of white meat from this preparatory step as well as small pieces from the filling table are run through a meat grinder for potted tuna or packed as small pieces for salads and sandwiches. The waste, as
APPETIZING

skin, bones, and undesirable parts, are dried and utilized for fertilizer or for poultry and stock feed.

The waste in the fish cleaning, that is in bones, skin, fins, and bits of meat not usable in the cans, amounts to practically 25 per cent, which combined with that in the butchering makes the total 60 per cent. In good factory practice, the loss will be more nearly 64 to 65 per cent.

The boards with the cut fish are distributed to the filling tables where all cans are filled by hand. The pieces are selected to give the maximum amount of solid chunks. Experience alone is a guide for neatness in arrangement and speed in this work. The filling is done by weight and any deficiency is made up from small bits. Plain cans only are used.

The fish is always packed with oil and salt. In probably the majority of cases the oil is measured into the can before the meat is packed, but in some respects this is objectionable because it makes the work rather mussy. Adding the oil after the fish has been filled has one disadvantage in that the penetration of the oil into the spaces and between the pieces is often slow and irregular. A bland salad oil, such as cottonseed, is used almost exclusively, one and one-half ounces to the half-pound can, and a proportionate amount for the other sizes. The salt may be added either before or after the filling with the meat, and is done by machine.

The cans have the covers clinched on and are run through a short exhaust box to eliminate air from between the pieces and from the headspace as the pre-cooking had the effect of getting rid of all gases from the tissues. The vacuum sealing process is also used with even more uniform results. In the past some packers have not exhausted the fish but this practice cannot be recommended.

Cooking

Cooking is done in the usual batch retort. The cans were formerly laid in pans and stacked on cars which were run into the retort, but at present are discharged from the closing machine into large wire boxes mounted on wheels, a procedure involving less labor.

The time and temperature for cooking tuna on the Pacific Coast is regulated by the California State Board of Health, and provides that the one-quarter pound can receive 240° F. for 65 minutes; the one-half pound can, 75 minutes; and the one-pound can 95 minutes.

Upon being taken out of the retort, the cans are washed in an alkaline bath and then sprayed with hot water to remove surface oil. A more recent modification is to wash the cans as they come from the closing machine by running them through a covered runway, playing a strong spray of alkaline solution upon them, then rinsing with hot water. The small amount of oil released in the retort is practically negligible and the cost of doing the work following the sealing machine is less than making it a separate job after cooking. The cooling is done in the air.

Cans are not outside lacquered except upon the order of the buyer.

Tonno Style

The tuna meat for paste is dark meat run through an Enterprise style of grinder, and olive oil and salt added in about double the regular proportion. Spices, such as pepper, may or may not be added. The cans are filled by
weight and given the same cook as for the regular pack. Quarter- and half-pound tins only are used.

**Label Weights**

No. $\frac{1}{4}$ can, $3\frac{1}{4}$ ozs.; No. $\frac{1}{2}$, 7 ozs.; No. 1, 13 ozs. Tuna flakes: No. $\frac{1}{2}$, $6\frac{1}{2}$ ozs.; and No. 1, 13 ozs.

**Comment**

A ton of tuna as landed at the factory will produce on an average 23 cases of one-pound flat cans, 48 cans to the case or 45 cases of one-half pound cans, 48 to the case.

**Specialties**

Two specialties have been patented under Nos. 1,143,087, June 15, 1915, and 1,174,635, March 7, 1916, issued to H. L. Stafford, Long Beach, California. The following is quoted from the first.

In preparing my food product, I first steam or cook the fish and the white meat is picked out. The dark meat, fat parts, and bellies, and other edible parts exclusive of the bones, I then grind. This ground meat does not contain sufficient oil and juice, and I take other dark meat and fat parts, bellies, and other edible parts and subject it to pressure to squeeze the fish oil and juice therefrom, and take this fish oil and juice and add it to the ground meat mixing it therewith and imparting the necessary additional flavor and juice. I also add spices, for example, as follows: Dried red pepper, white pepper, cayenne pepper, dried yellow pepper, Hungarian paprika, cinnamon, cloves, mace, coriander, East Indian curry, marjoram, bay leaves, rosemary. I also mix the necessary amount of salt and a sufficient amount of expressed juice is added to make the patty in a moist state suitable for sandwiches. The fish prepared in this way is packed in tins and boxes in the usual way and the product is extremely palatable and nutritious.

The subsequent patent goes a step farther and provides that the tuna mixture be put in casings slightly smaller than the inside diameter of the can to be used, that the stuffed casing be smoked as much as desirable, then cut across equal to the depth of the can, and the canning be carried out in the usual way. No packing is being done in line with the patent.

**S. R. A. No. 346. Notice to Packers of Tuna and Similar Fish. (Superseding Item 218. P. 61, Chemistry 20.)**

The following table contains the names of the species of tuna and similar fish commonly packed on the Pacific Coast, together with the names which, in the opinion of the Bureau, may properly be used on the labels:

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Names Which May Be Used on Labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germo alalunga (Thunnus alalunga, Starks)</td>
<td>Albacore, Tuna, Long-finned Tuna</td>
</tr>
<tr>
<td>Thunnus thynnus</td>
<td>Tuna, Blue-fin Tuna, Leaping Tuna</td>
</tr>
<tr>
<td>Germo macropterus or Germo germo (Thunnus macropterus, Starks)</td>
<td>Tuna, Yellow-fin Tuna</td>
</tr>
<tr>
<td>Gymnosardia pelamis (Euthynnus pelamis, Starks)</td>
<td>Striped Tuna</td>
</tr>
<tr>
<td>Sarda chilensis</td>
<td>Bonito, Bonita</td>
</tr>
<tr>
<td>Seriola dorsalis</td>
<td>Yellow Tail, Amber Fish</td>
</tr>
</tbody>
</table>

By trade usage and understanding the terms “white meat tuna,” “tuna, white meat only,” and equivalent expressions appear to be applied to the white meat of Germo alalunga. The use of these terms to describe the meats of Thunnus thynnus and Germo macropterus is likely to convey a false and misleading impression to the consumer.

The word “striped” should appear in type of the same prominence as the word “tuna.”
APPERTIZING

S. R. A. No. 390. Notice to Packers of Tuna and Similar Fish.

Item 346, page 18, Service and Regulatory Announcements, Chemistry 26, is hereby amended to permit the use of the name "tuna," unqualified, in the labeling of Gymnosarda pelamis (Euthynnus pelamis, Starks), described in item 346 under the common name "striped tuna." Objection will not be taken to labeling Gymnosarda pelamis packed in the so-called Italian style as "tonno."

LITERATURE

Beard, Harry R.

Cobb, John N.

Hunt, Arthur L.

Obst, M. M.

Schofield, W. L.

Stevenson, Charles H.

This is one of the finest bulletins upon commercial food preparation ever issued.

Tressler, Donald K.

APPENDIX

The First Salmon Cannery

R. D. Hume
(Pacific Fisherman, Vol. II, No. 1, January, 1904.)

Before the arrival of Mr. Hapgood (from Maine) the Hume brothers had purchased a large scow, on which they proposed to do the canning of salmon, and had added an extension to the cabin 18 by 24 feet in area, to be used as a can-making shop. This had a shed on the side next to the river for holding any cans that might be made in advance of the packing season. A few days after the arrival of Mr. Hapgood (March 23, 1864), the tools and machinery were packed and put in position. Mr. Hapgood made some stovepipe and two or three sheet-iron fire pots, and in a short time was ready for can making. The following list of tools and machinery will show how primitive our facilities were as compared with present methods:

1 screw hand press, 1 set cast-iron top dies, 1 set cast-iron bottom dies, 1 pair squaring shears, 1 pair rotary shears, 1 pair bench shears, 1 pair hand shears or snips, 1 pair 24-inch rolls, 1 anvil (weight 50 pounds), 1 forging hammer, 1 tinner's hammer, 1 set punches for making stove-
pipe, 1 rivet set, 1 grooving set, 2 iron slabs grooved on one side to mold strips of solder, 1 iron clamp to hold bodies of cans while soldering the seams, 1 triangular piece of cast iron about three-eighths of an inch in thickness and 6 inches in length, with a wooden handle attached to the apex, also used for holding can bodies in place while being seamed.

The process of canning was as follows: The bodies of the cans were first cut to proper size by the squaring shears, a line was then scribed with a gage about three-sixteenths of an inch from one edge, and they were next formed into cylindrical shape by the rolls. They were then taken to the soldering bench, and one edge lapped by the other until the edge met the line that had to hold them in place for the further purpose of seaming. They were then placed either in the iron clamp, which had a piece of wood attached to its under side, and held firmly, the clamp being closed by the operation of a treadle, or were slipped on a piece of wood, which was bolted to the bench, while being held in place by the triangular hand seamer, which was pressed down on the lap of the seam by the left hand of the operator. When this had been done a piece of solder, which had been prepared by shaking in a can together with rosin, was placed on the seam, and melted and rubbed lengthwise of the seam. After cooling the bodies were ready for the end or bottom, which operation was brought about by first cutting out circular blanks with the rotary shears, and then placing them in the cast-iron die, and bringing the handle of the screw press around with a swing with force enough to form up the end or bottom. In this operation there were many difficulties, as the ends or bottoms would many times stick to the upper part of the die and refuse to come off, and fingernails were pretty short in those days. To get the ends out of the lower part of the die was not so bad, as a wooden plunger operated by a treadle knocked them out, but sometimes they were in pretty bad shape. When the bottoms or ends were ready they were slipped on the bodies, and the edge of the bottom rolled about in a pan of powdered rosin until the seam was well dusted. A piece of solder similar in size and preparation as used for the side seam was placed in the can. They were then placed on the smooth side of the cast-iron slabs, and the operator, with a hot soldering copper shaped to fit the circle of the can, melted the solder and, by turning the can rapidly, soldered the full circumference. The output of this can factory was very imperfect, as at least one-half of the seams burst, owing to the lack of experience of the manager or want of good judgment.

When the can making was well under way, Mr. Hapgood then turned his attention to getting the apparatus for canning on board the house boat. This in the cooking department consisted of a kettle made of boiler iron about 36 inches in diameter and 5 feet in depth, set in a brick furnace and fired from underneath. Alongside was a round bottom cast-iron pot holding about 60 gallons of water and heated in the same manner. These kettles, with a dozen coolers or circular sheet-iron pans with ropes attached and with holes cut in the bottoms for drainage, a set of 5-inch blocks and tackle, with a sheet-iron fire pot and a scratch awl, completed the bathroom outfit. The can filling and soldering room was furnished with a table through the center, where cutting the salmon in pieces to suit and the filling of the cans was done. On each side of the room there was a bench running the full length, on the end of one of which the cans were placed to receive the pickle,
which was used at that time instead of the small quantity of salt that is placed in the cans during the operation of these later days. After the salmon had been cleaned by removing the entrails and washing them outside the covered portion of the scow, they were brought inside and placed on the table, and a man with a butcher knife in one hand and a stick in the other, which had a mark showing the length of the pieces desired, cut gashes in the side of the salmon as a guide, and then cut the fish into sections corresponding to the length of the mark on the stick. He then proceeded to cut the sections in pieces to suit the cans. Then three or four operators placed the salmons in the cans and shoved them along the table to where a boy wiped the top edge and passed them along to two others who placed tops which fitted inside of the rim. The cans were then taken in wooden trays to the bench opposite the starting point, which was fitted with four sheet-iron pots, and at the one nearest the entrance to the house on the scow a man put a soldering flux on the top edge, which was made by adding zinc to muriatic acid, and then with a pointed soldering copper and a stick of solder melted the solder until a small portion could be drawn around the groove formed by the edge of the can and the bevel of the top. From there the cans were taken to the other parts of the bench, where two men finished soldering the head in, and then taken to the third man, who soldered, or, as it was called, buttoned the end of the seam lap. The cooking department or bathroom, as it was called, was separated from the filling and soldering room by a partition. The cans were shoved through a hole in the partition.

At this time the process was a secret. Mr. Hapgood did the cooking and all the work done inside, no one but a member of the firm being allowed to go in. This privacy was continued until the firm moved to the Columbia River and, the labor becoming too arduous for Mr. Hapgood to perform alone, a boy by the name of Charlie Taylor was taken in as an assistant.

But to return to the original proposition: When the filled cans had been soldered and entered the bathroom they were put in the coolers and lowered into a cast-iron pot, one cooler of cans being cooked at a time. The cooler was lowered into the boiling fresh water until the cans were submerged to within one inch of the top ends and left to cook for one hour; then they were hoisted out and the vent holes in the center of the top soldered up, after which they were dumped into the boiler-iron kettle, which held a solution of salt and water of density sufficient to produce, when boiling, a heat of 228° to 230° F. They were cooked in this solution for one hour and then taken out of the kettle with an iron scoop shaped like a dip net, with a wooden handle about 6 feet in length. They were dumped into a tank of water on the other side of the partition which separated the bathroom from the packing room through an opening in the partition, receiving many a bump and bruise in the operation. Then they were washed with soap and rag to remove the dirt and grease, each can being handled separately. When this was done they were piled on the floor of the packing room and in a few days were painted with a mixture of red lead, turpentine and linseed oil, for at that time buyers would have no canned salmon, no matter how good the quality, unless the cans were painted red.
REGULATIONS

The food industries have been subject to more or less regulation from time immemorial. They have taken the character of regulations for religious observances, protection of health, protection against famine, insurance in the collection of taxes, measures for creating craft guilds or trade unions, and for the creation of public offices.

The present theory of regulation in this country is: First, that it is for the protection of public health in that only sound wholesome materials may be used, that all preparatory work be done in a proper manner under sanitary conditions, and that delivery to the consumer be made in the same condition. Second, that the food be properly labeled for the information of the buyer. With these two objectives all reasonable persons agree.

However, regulation itself needs to be reasonable, easily understood and capable of being fulfilled in commercial practice. Due to the fact that some canners have not met their obligations as fully as they should has resulted in regulations being drawn by others and in some cases carried to extremes, particularly in minor details. This is well illustrated in the United States Standards for grades of various products, as for illustration, canned tomatoes. The capacity of the can is defined in terms of avoirdupois ounces. For example, a No. 2 can is rated as holding 20.55 ounces of water, a No. 2½ can, 29.79 ounces, and so on. But where can a packer buy a commercial scale which will weigh 29.79 ounces, or what apparatus maker offers scales or weights that register in terms of a hundredth of an ounce? They certainly are not standard equipment. With foods which sell for ten or fifteen cents per can it is doubtful whether consumers are interested to the extent that the weighing be done as close as the equivalent of one or two peas.

Headspace in a can is the space between the food and the underside of the cover but the measurement is given in terms from the level of the contents to the top of the double seam on the end. This measurement is deemed so important that it is expressed in tenths of a sixteenth of an inch. In the examples just cited the headspace for a No. 2 can is given as 9.7 sixteenths of an inch and for the No. 2½ can as 9.9 sixteenths of an inch. This requires an inch rule to be divided into 160 parts, something not on the market, and if available could not be read by the unaided eye nor manipulated by hand to obtain the measurement. Cans are not made with the accuracy to admit of such measurements, the dies for stamping the ends vary more than a hundred and sixtieth of an inch in depth, the double seams are not within that range, nor even the tin-plate from which the covers are stamped. No filling machine is made which could operate with such precision. A few degrees variation in temperature, a slight difference in vacuum, or even the pressure upon the side of the can in lifting it might make much more difference than the tenth of a sixteenth of an inch. If the variations in the con-
tainers and in practical filling are inherently greater than the unit of measurement why incorporate it in regulations which have the effect of law?

Regulations which are so obviously impractical have the effect of discounting the whole. Headspace is important in the canning of foods but needs to be varied under certain conditions in the same product and also for different products and not according to a mathematical formula. Under no known circumstance should it be necessary to use a micrometer in determining whether a can is properly filled and especially when regulations are already in force establishing the minimum weights which must be maintained.
INDEX
INDEX

Ainsley, J. C. Pioneered canning fruits for salad 209
Appert, Portrait 5
Appert, Title page 6
Appert's work. Edinburgh Review 25
Apple 118
Apple, baked 134
Apple butter 141
Apple honeys 149
Apple jam 140
Apple jelly 149
Apple sauce 135
Apple sauce, canned. U. S. Standards 137
Apple sirup 148
Apples for canning. U. S. Standards 120
Apples, gas in 131
Apricot 150
Archdeacon, W. Early canning of meat 762
Arnold, L. E. Patent on coloring pineapple 336
Art of preserving. Appert. Title page 46
Artichoke 353
Artichokes. Italian canning 362
Ash, C. S. Patent on stabilizing pineapple 343
Asparagus 367
Baldwin, W. Patent on treating pineapple 336
Barlow, Bronson. Flat sours in canned corn 115
Barlow, Bronson. Spoilage of canned corn 112
Bartlett, G. M. Patent on canning baked beans 419
Bean cutters, patents 429
Bean graders, patents 429
Bean snippers 430
Beans 389
Beans, asparagus style 397
Beans, baked 404
Beans, California pink 428
Beans, canned. U. S. Standards 398
Beans, lima 421
Beans, lima canned. U. S. Standards 422
Beans, pinto 428
Beans, red kidney 427
Beans, soy 428
Beans, wax 398
Beans with pork 404
Beef, corned 770
Beef, roast 770
Beets 433
Beets, canned. U. S. Standards 438
Beet tops 441
Berries 155
Bitting, K. G. A Benefactor of Humanity 7
Black, J. W. Patent on canning ham 765
Blackberry 156
Blueberry 159
Bogle, C. M. Patent on sauerkraut juice 474
Borden, Gail. Patent on concentrated cider 145
Patents on concentration of milk 732
Bouchet, Marie L. Patent on macaroni 696
Bowers, J. S. Patent on canning prunes 349
Broccoli 472
Brussels sprouts 472
Buhles, W. O. Patent to color olives 253
Bunzl, Julius. Patent on Mexican style tamales 777
Burt, H. P. and Burt, G. Patent on canning olives 261
Cabbage 442
Cabbage and sauerkraut machine patents 475
Cabbage, canned 473
Cabbage for kraut. U. S. Standards 449
Carpenter, L. E. Patent on Sterilizing Swiss cheese 760
Carrot 476
Cauliflower 473
Celeriac 481
Celery 479
Cheese 757
Cherries 181
Cherries, canned. U. S. Standards 185
INDEX

Cherries, Maraschino style ........................................... 194
Cherries, Maraschino style, domestic preparation ................. 197
Cherries, sour .................................................................. 182
Cherries, sour, U. S. Standards ......................................... 183
Cherries, sweet .................................................................. 189
Chicken ........................................................................... 779
Chicken, boiled .................................................................. 781
Chicken, boned .................................................................. 782
Chicken, whole ................................................................... 781
Chili sauce .......................................................................... 675
Chisholm, C. P. and J. A. Patent on a pea shelter ................. 584
Chlorosis in pineapple ........................................................ 312
Cider ................................................................................ 142
Cider, concentrated ............................................................ 145
Clams ............................................................................... 785
Clam chowder ..................................................................... 789
Clams, hard ......................................................................... 787
Clams, razor ........................................................................ 788
Cocktail, fruit ..................................................................... 213
Cocktail sauce ...................................................................... 675
Codfish hash ....................................................................... 791
Coons, B. C. Patent on canning apples ................................. 128
Corn .................................................................................. 482
Corn and tomatoes ............................................................. 522
Corn, canned, cream style, U. S. Standards ......................... 513
Corn canning, Douthitt patent ............................................. 520
Corn, cause of sour, W. L. Underwood ................................. 78
Corn, cause of sour, S. C. Prescott ...................................... 71
Corn, controlling consistency ................................................ 508
Corn, flat sours in canned, Bronson Barlow ......................... 115
Corn for canning, U. S. Standards ....................................... 498
Corn, hulled ......................................................................... 521
Corn, Maryland style .......................................................... 516
Corn meal mush .................................................................. 532
Corn on cob ......................................................................... 521
Corn sirup ........................................................................... 717
Corn, spoilage of canned, Bronson Barlow ......................... 112
Corn, whole grain, U. S. Standards ..................................... 518
Crabs .................................................................................. 791
Crabs, Japanese spider ....................................................... 792
Cranberry ........................................................................... 161
Crawford, S. L. Patent on canning apples .............................. 127
Crayfish, sea ...................................................................... 835
Crussis, W. V. Patent for packing olives .............................. 254
Currant .............................................................................. 168
Dale, J. K. Patent on sirup from raisins ............................... 722
Darling, E. R. Patent on apple juice .................................... 147
Davis, A. R. Patent on apple sauce ....................................... 139
Dewberry .......................................................................... 169
Douthitt, M. V. Patent on canning corn ................................. 520
Dunbar, G. W. Patent on bag-lining for cans ....................... 836
Durand, Peter. Earliest English patent on canning .............. 23
Edinburgh Review. Discussion of the work of Appert .......... 25
Figs ................................................................................... 199
Figs, California packing ....................................................... 205
Figs, Celeste ....................................................................... 202
Figs, Texas packing ............................................................. 204
Fish .................................................................................... 784
Fish flakes .......................................................................... 794
Fish roe .............................................................................. 795
Fitzgerald, F. F. Ketchup ..................................................... 675
Fruits for salad .................................................................... 209
Fruit cocktail ....................................................................... 213
Fruits spiced ....................................................................... 214
Gahan, A. S. Patent on canning figs ..................................... 208
Garbanzos ........................................................................... 429
Garstin, G. H. Patent on improved canned cheese .............. 759
Gaseous fermentation in peas, H. L. Russell ......................... 47
Gibault on pineapple ........................................................... 300
Ginaca, H. G. Patent for vacuumizing pineapples ............... 341
Gooseberries ...................................................................... 169
Gore, H. C. Patent on apple sirup ......................................... 148
Gore, H. C. Patent on sirup from beets ................................. 721
Grab, E. G. Patent to remove gas from apples ................... 125
Graef, C. Patent on concentrated cider ................................. 146
Graham, L. M. Improved method for washing fruit ............... 276
Grapefruit .......................................................................... 215
Grapefruit, canned, U. S. Standards .................................... 223
<table>
<thead>
<tr>
<th>INDEX</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grapefruit juice</td>
<td>222</td>
</tr>
<tr>
<td>Grapes</td>
<td>227</td>
</tr>
<tr>
<td>Gray, H. E. Pioneered canning fruit cocktail</td>
<td>213</td>
</tr>
<tr>
<td>Gray, H. E. and A. M. Erickson. Patent on fruit cocktail</td>
<td>214</td>
</tr>
<tr>
<td>Greco, A. Originated asparagus style packing beans</td>
<td>397</td>
</tr>
<tr>
<td>Greens</td>
<td>532</td>
</tr>
<tr>
<td>Halfhill, A. P. Preparation of tuna</td>
<td>842</td>
</tr>
<tr>
<td>Hann, Rosa Dean. Patent on treating olives</td>
<td>253</td>
</tr>
<tr>
<td>Hansen, O. H. Patent to prevent pinholing</td>
<td>126</td>
</tr>
<tr>
<td>Hash, corned beef</td>
<td>773</td>
</tr>
<tr>
<td>Herbert, F. B. Patent on curing olives</td>
<td>241</td>
</tr>
<tr>
<td>Hickmott, Robert Pioneered California packing of asparagus</td>
<td>373</td>
</tr>
<tr>
<td>Hook, B. A. Patent on blanching spinach</td>
<td>623</td>
</tr>
<tr>
<td>Hominy</td>
<td>527</td>
</tr>
<tr>
<td>Honey</td>
<td>724</td>
</tr>
<tr>
<td>Houck, A. W. Pioneered on grapefruit</td>
<td>216</td>
</tr>
<tr>
<td>Howard, B. J. Method of examining tomato products</td>
<td>682</td>
</tr>
<tr>
<td>Hume, R. D. The first salmon cannery</td>
<td>848</td>
</tr>
<tr>
<td>Hurst, Lewis. Patent on apple-honeys</td>
<td>149</td>
</tr>
<tr>
<td>Irwin, J. H. Patent on canning macaroni</td>
<td>696</td>
</tr>
<tr>
<td>Jacob, E. H. Patent on preserving mushrooms</td>
<td>542</td>
</tr>
<tr>
<td>Jeffries, F. L. Patent on apple jelly</td>
<td>149</td>
</tr>
<tr>
<td>Johnson, M. O. Patent for treating fruit juices</td>
<td>342</td>
</tr>
<tr>
<td>Jones, J. W. Patent on canning meat</td>
<td>764</td>
</tr>
<tr>
<td>Kemp, W. Patent on tomato juice</td>
<td>681</td>
</tr>
<tr>
<td>Ketchup, factory control of. F. F. Fitzgerald</td>
<td>675</td>
</tr>
<tr>
<td>Kidwell, Captain, and Hawaiian Pineapple</td>
<td>306</td>
</tr>
<tr>
<td>Kraft, J. L. Patents on canning cheese</td>
<td>757</td>
</tr>
<tr>
<td>L'Art de Conserver. Title page</td>
<td>6</td>
</tr>
<tr>
<td>Lawrence, D. M. Patent on cooking fish for canning</td>
<td>834</td>
</tr>
<tr>
<td>Lewis, W. K. Patent on baked beans</td>
<td>406</td>
</tr>
<tr>
<td>Libby, F. O. Patent on canned baked beans</td>
<td>417</td>
</tr>
<tr>
<td>Lobster</td>
<td>796</td>
</tr>
<tr>
<td>Lobster, discoloration in canned</td>
<td>86</td>
</tr>
<tr>
<td>Andrew Macphail</td>
<td>171</td>
</tr>
<tr>
<td>Loganberry</td>
<td>272</td>
</tr>
<tr>
<td>Logan, J. H. Discoverer of the loganberry</td>
<td>251</td>
</tr>
<tr>
<td>Leaf peeling</td>
<td>692</td>
</tr>
<tr>
<td>Macedoines</td>
<td>533</td>
</tr>
<tr>
<td>Mahan, S. W. Patent on improving cider</td>
<td>146</td>
</tr>
<tr>
<td>Mackerel</td>
<td>797</td>
</tr>
<tr>
<td>Macphail, Andrew. Discoloration in canned lobster</td>
<td>86</td>
</tr>
<tr>
<td>Maple sirup</td>
<td>712</td>
</tr>
<tr>
<td>Maple sugar</td>
<td>714</td>
</tr>
<tr>
<td>Mayhew, George Patent on peeling pears</td>
<td>289</td>
</tr>
<tr>
<td>McCrosson, J. T. Patent on canning pineapple</td>
<td>344</td>
</tr>
<tr>
<td>McGeorge, W. T. Patent on treating fruit juices</td>
<td>343</td>
</tr>
<tr>
<td>McGowan, James. Patent on canning spaghetti</td>
<td>698</td>
</tr>
<tr>
<td>Meister, C. J. Controlling consistency of corn</td>
<td>508</td>
</tr>
<tr>
<td>Meister, C. J. Testing consistency of corn</td>
<td>526</td>
</tr>
<tr>
<td>Meyenberg, John. Patents on evaporated milk</td>
<td>738</td>
</tr>
<tr>
<td>Meyer, G. Patents on canning cheese</td>
<td>761</td>
</tr>
<tr>
<td>Meat</td>
<td>762</td>
</tr>
<tr>
<td>Meat, boiled</td>
<td>768</td>
</tr>
<tr>
<td>Meat canning literature</td>
<td>782</td>
</tr>
<tr>
<td>Meat, potted</td>
<td>774</td>
</tr>
<tr>
<td>Meat stews</td>
<td>769</td>
</tr>
<tr>
<td>Meat stock</td>
<td>770</td>
</tr>
<tr>
<td>Micro-organisms and sterilizing processes. Prescott and Underwood</td>
<td>51</td>
</tr>
<tr>
<td>Milk</td>
<td>728</td>
</tr>
<tr>
<td>Milk, sterilized evaporated</td>
<td>736</td>
</tr>
<tr>
<td>Molasses</td>
<td>711</td>
</tr>
<tr>
<td>Moore, T. C. Patent on preserving figs</td>
<td>208</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>534</td>
</tr>
<tr>
<td>Mushroom canning patent</td>
<td>542</td>
</tr>
<tr>
<td>Mutton stews</td>
<td>769</td>
</tr>
<tr>
<td>Item</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Okra</td>
<td>543</td>
</tr>
<tr>
<td>Olives</td>
<td>232</td>
</tr>
<tr>
<td>Olives, history</td>
<td>232</td>
</tr>
<tr>
<td>Orange</td>
<td>263</td>
</tr>
<tr>
<td>Orange juice</td>
<td>265</td>
</tr>
<tr>
<td>Orange, Japanese packing</td>
<td>264</td>
</tr>
<tr>
<td>Ortega, C.</td>
<td></td>
</tr>
<tr>
<td>Patent on pimiento specialty</td>
<td>597</td>
</tr>
<tr>
<td>Oysters</td>
<td>800</td>
</tr>
<tr>
<td>Oyster juice</td>
<td>804</td>
</tr>
<tr>
<td>Oysters, Pacific Coast</td>
<td>802</td>
</tr>
<tr>
<td>Paper mulch for pineapple</td>
<td>311</td>
</tr>
<tr>
<td>Parsnip</td>
<td>545</td>
</tr>
<tr>
<td>Pastes, alimentary</td>
<td>692</td>
</tr>
<tr>
<td>Pasteur, Louis. Portrait</td>
<td>45</td>
</tr>
<tr>
<td>Peaches</td>
<td>267</td>
</tr>
<tr>
<td>Peaches, canned. U. S. Standards</td>
<td>283</td>
</tr>
<tr>
<td>Peaches, lye peeling</td>
<td>272</td>
</tr>
<tr>
<td>Pea blancher</td>
<td>588</td>
</tr>
<tr>
<td>Pea cleaning and washing patents</td>
<td>587</td>
</tr>
<tr>
<td>Pea graders by gravity</td>
<td>587</td>
</tr>
<tr>
<td>Pea graders for size</td>
<td>586</td>
</tr>
<tr>
<td>Pea sheller. Madam Faure</td>
<td>554</td>
</tr>
<tr>
<td>Pea sheller. C. P. and J. Chisholm patent</td>
<td>584</td>
</tr>
<tr>
<td>Pea sheller. R. P. Scott patent</td>
<td>581</td>
</tr>
<tr>
<td>Pea shelling devices, patents</td>
<td>581</td>
</tr>
<tr>
<td>Pea viner. Scott-Chisholm patents</td>
<td>583</td>
</tr>
<tr>
<td>Peas</td>
<td>546</td>
</tr>
<tr>
<td>Peas, canned. U. S. Standards</td>
<td>572</td>
</tr>
<tr>
<td>Peas, discolored by copper</td>
<td>577</td>
</tr>
<tr>
<td>Pear</td>
<td>287</td>
</tr>
<tr>
<td>Peppers, pimientos, chillies</td>
<td>590</td>
</tr>
<tr>
<td>Pimientos</td>
<td>590</td>
</tr>
<tr>
<td>Pimientos, California canning</td>
<td>596</td>
</tr>
<tr>
<td>Pimientos, Georgia canning</td>
<td>594</td>
</tr>
<tr>
<td>Pimiento specialty</td>
<td>597</td>
</tr>
<tr>
<td>Pineapple</td>
<td>294</td>
</tr>
<tr>
<td>Pineapple bran</td>
<td>330</td>
</tr>
<tr>
<td>Pineapple cutters and graters,</td>
<td>334</td>
</tr>
<tr>
<td>patents</td>
<td></td>
</tr>
<tr>
<td>Pineapple, crushed</td>
<td>323</td>
</tr>
<tr>
<td>Pineapple, Dole development in</td>
<td>307</td>
</tr>
<tr>
<td>canning</td>
<td></td>
</tr>
<tr>
<td>Pineapple in England</td>
<td>302</td>
</tr>
<tr>
<td>Pineapple introduced in Hawaii</td>
<td>305</td>
</tr>
<tr>
<td>Pineapple juice</td>
<td>325</td>
</tr>
<tr>
<td>Pineapple, sizing, coring, and</td>
<td>351</td>
</tr>
<tr>
<td>slicing machines, patents</td>
<td></td>
</tr>
<tr>
<td>Plum</td>
<td>346</td>
</tr>
<tr>
<td>Potato</td>
<td>598</td>
</tr>
<tr>
<td>Poultry</td>
<td>778</td>
</tr>
<tr>
<td>Prescott, S. C. Cause of sour corn</td>
<td>71</td>
</tr>
<tr>
<td>Prescott and Underwood, picture</td>
<td>50</td>
</tr>
<tr>
<td>Prescott and Underwood.</td>
<td></td>
</tr>
<tr>
<td>Micro-organisms and sterilizing</td>
<td>51</td>
</tr>
<tr>
<td>processes</td>
<td></td>
</tr>
<tr>
<td>Prescott and Underwood.</td>
<td></td>
</tr>
<tr>
<td>Packing sweet corn</td>
<td>62</td>
</tr>
<tr>
<td>Preserving fruit without sugar.</td>
<td></td>
</tr>
<tr>
<td>T. Saddington</td>
<td>19</td>
</tr>
<tr>
<td>Prunes</td>
<td>349</td>
</tr>
<tr>
<td>Pumpkin and squash</td>
<td>600</td>
</tr>
<tr>
<td>U. S. Standards</td>
<td>606</td>
</tr>
<tr>
<td>Quince</td>
<td>351</td>
</tr>
<tr>
<td>Raisins, canned</td>
<td>231</td>
</tr>
<tr>
<td>Raisin sirup</td>
<td>722</td>
</tr>
<tr>
<td>Raspberry</td>
<td>173</td>
</tr>
<tr>
<td>Regulations</td>
<td>851</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>609</td>
</tr>
<tr>
<td>Rich, S. Patent on codfish hash</td>
<td>791</td>
</tr>
<tr>
<td>Richardson, A. B.</td>
<td></td>
</tr>
<tr>
<td>Patent on canning hams</td>
<td>764</td>
</tr>
<tr>
<td>Russell, H. L.</td>
<td></td>
</tr>
<tr>
<td>Gaseous fermentation in canning</td>
<td>47</td>
</tr>
<tr>
<td>Salad, fruits for</td>
<td>209</td>
</tr>
<tr>
<td>Salmon</td>
<td>805</td>
</tr>
<tr>
<td>Salmon cannery. Hume</td>
<td>848</td>
</tr>
<tr>
<td>Salsify</td>
<td>612</td>
</tr>
<tr>
<td>Sampson, Abiel.</td>
<td></td>
</tr>
<tr>
<td>Patent on preserving cranberries</td>
<td>164</td>
</tr>
<tr>
<td>Sanborn, G. O.</td>
<td></td>
</tr>
<tr>
<td>Patent on baked apple</td>
<td>134</td>
</tr>
<tr>
<td>Sardines</td>
<td>815</td>
</tr>
<tr>
<td>Sardines, Atlantic</td>
<td>818</td>
</tr>
<tr>
<td>Sardines, canning raw fish</td>
<td>830</td>
</tr>
<tr>
<td>Sardines, Pacific Coast</td>
<td>825</td>
</tr>
<tr>
<td>Sauerkraut</td>
<td>442</td>
</tr>
<tr>
<td>Sauerkraut. U. S. Standards</td>
<td>464</td>
</tr>
<tr>
<td>Sauerkrut juice</td>
<td>467</td>
</tr>
<tr>
<td>Sauerkrut juice, concentrated</td>
<td>474</td>
</tr>
<tr>
<td>Sausage</td>
<td>774</td>
</tr>
<tr>
<td>Sausage, Country Style</td>
<td>776</td>
</tr>
<tr>
<td>Sausage, frankfurter</td>
<td>776</td>
</tr>
<tr>
<td>Sausage, Vienna</td>
<td>775</td>
</tr>
<tr>
<td>Scott, A. T. Patent for refining</td>
<td>345</td>
</tr>
<tr>
<td>pineapple juice</td>
<td></td>
</tr>
<tr>
<td>Scott, R. P. Patent on pea podder</td>
<td>581</td>
</tr>
<tr>
<td>Scott, R. P. and J. A. Chisholm.</td>
<td>583</td>
</tr>
<tr>
<td>Patent on shelling peas</td>
<td></td>
</tr>
<tr>
<td>Sellars, W. S.</td>
<td></td>
</tr>
<tr>
<td>Patent to remove gas</td>
<td>124</td>
</tr>
<tr>
<td>Name</td>
<td>Invention/Process</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>Scllman, Henry</td>
<td>Patent on drying sardines</td>
</tr>
<tr>
<td>Sells, Ogden S.</td>
<td>Patent on cooking corn</td>
</tr>
<tr>
<td>Shrimp</td>
<td></td>
</tr>
<tr>
<td>Simpson, C. H.</td>
<td>Patent on applesauce</td>
</tr>
<tr>
<td>Sirup and molasses</td>
<td></td>
</tr>
<tr>
<td>Smith, I. V.</td>
<td>Introduced canned hominy</td>
</tr>
<tr>
<td>Sorghum sirup</td>
<td></td>
</tr>
<tr>
<td>Spaghetti</td>
<td></td>
</tr>
<tr>
<td>Specialties</td>
<td></td>
</tr>
<tr>
<td>Spinach</td>
<td></td>
</tr>
<tr>
<td>Spinach, canned</td>
<td>U. S. Standards</td>
</tr>
<tr>
<td>Spinach for canning</td>
<td></td>
</tr>
<tr>
<td>Squash</td>
<td></td>
</tr>
<tr>
<td>Stafford, H. L.</td>
<td>Patent on tuna specialty</td>
</tr>
<tr>
<td>Staley, H. C.</td>
<td>Patent on canning olives</td>
</tr>
<tr>
<td>Strained foods</td>
<td></td>
</tr>
<tr>
<td>Strawberry</td>
<td>U. S. Standards</td>
</tr>
<tr>
<td>Succotash</td>
<td></td>
</tr>
<tr>
<td>Sugar beet sirup</td>
<td></td>
</tr>
<tr>
<td>Sugar cane sirup</td>
<td></td>
</tr>
<tr>
<td>Sweet corn, packing of</td>
<td></td>
</tr>
<tr>
<td>Sweet potato</td>
<td></td>
</tr>
<tr>
<td>Tamale</td>
<td></td>
</tr>
<tr>
<td>Taylor, W. E.</td>
<td>Patent on cooking fish</td>
</tr>
<tr>
<td>Thomas, W. E.</td>
<td>Patent on blanching spinach</td>
</tr>
<tr>
<td>Thompson, A. R.</td>
<td>Patent on continuous system of sterilizing</td>
</tr>
<tr>
<td>Tomato</td>
<td></td>
</tr>
<tr>
<td>Tomato, canned</td>
<td>U. S. Standards</td>
</tr>
<tr>
<td>Tomato juice</td>
<td></td>
</tr>
<tr>
<td>Tomato ketchup</td>
<td></td>
</tr>
<tr>
<td>Tomato paste</td>
<td></td>
</tr>
<tr>
<td>Tomato products, examination of</td>
<td></td>
</tr>
<tr>
<td>Tomato pulp</td>
<td></td>
</tr>
<tr>
<td>Tomato pulp, U. S. Standards</td>
<td></td>
</tr>
<tr>
<td>Tongue</td>
<td></td>
</tr>
<tr>
<td>Tuna</td>
<td></td>
</tr>
<tr>
<td>Turner, James</td>
<td>Patent on canning meat</td>
</tr>
<tr>
<td>Turnip</td>
<td></td>
</tr>
<tr>
<td>Underwood, W. L.</td>
<td>Cause and prevention of sour corn</td>
</tr>
<tr>
<td>Underwood and Prescott</td>
<td>Picture</td>
</tr>
<tr>
<td>Underwood, W. L., Prescott, S. C.</td>
<td>Packing of sweet corn</td>
</tr>
<tr>
<td>Underwood, W. L., Prescott, S. C.</td>
<td>Micro-organisms and sterilizing processes</td>
</tr>
<tr>
<td>Van Camp, Frank</td>
<td>originated tomato sauce for baked beans</td>
</tr>
<tr>
<td>Wilson, John A.</td>
<td>Patent on canning meat</td>
</tr>
<tr>
<td>Wolff, H. N.</td>
<td>Patent on curing olives</td>
</tr>
<tr>
<td>Yam, candied</td>
<td></td>
</tr>
</tbody>
</table>