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Zaidee Elizabeth Bonney for the M. S. in Nutrition
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(Major Professor)

Owing to the increasing importance of the frozen-pack industry in the Pacific Northwest, it seemed expedient to make a study of the use of frozen-pack peas from the standpoint of the home consumer. Although a number of trade journals had published articles about the recently developed industry in relation to the necessity of pre-scalding, to the lack of danger from toxin produced by Clostridium botulinum, to the best temperature for storage, to the suitability of special containers, and to the procedures involved in marketing the product, no standard method for cooking frozen-pack peas based on laboratory experiments was available to the home maker. There was also no record of the practicability of the use of various home cooling devices for temporary storage of the frozen-pack peas. Therefore, a study was undertaken: (1) to develop a standard method of cooking frozen-pack peas; (2) to ascertain the practicability of keeping frozen-pack peas in the home for a brief period of time before cooking; (3) to compare the cooked frozen-pack with the cooked fresh and canned peas; and (4) to judge the relative economy of the use of frozen-pack peas.

Factors relating to the preservation of the attractive color of chlorophyll and the nutritive value of peas were considered in the method of cooking. Only sweet garden varieties of peas that have an abundance of chlorophyll in the epidermis and a pleasing flavor are adapted to the freezing process. In a recent varietal study conducted by the United States Frozen Pack Laboratory, the following varieties which had been preserved by the frozen-pack method were rated high after a five minute boiling period: (World's Record, President Wilson, Alderman, and Teton (Thomas Laxton, wilt resistant).

From the laboratory experiments conducted in this study, it was found that the depth and width of saucepan of suitable size for cooking two cups of peas, the amount of water, and the material of the utensil did not effect the product to any significant degree. It was also shown that substituting tap water with a hydrogen ion concentration of 7.1 for distilled

water and cooking peas immediately after defrosting did not effect the product. Optimal results for palatability were obtained in cooking frozen-pack peas when the boiling period was three or four minutes. The flavor of the peas was improved by adding the salt before rather than after the cooking period. Directions for cooking and a household recipe were developed from the results of the experiments.

In determining the possibilities of keeping frozen peas in the home temporarily, it was found that the peas were defrosted in six and a half hours at room temperature, in eighteen hours in an ice-cooled refrigerator, and in twenty hours on the top shelf and forty-two hours on the bottom shelf of a mechanical refrigerator. When some peas were kept at room temperature (68° F.) for four days the bacterial count per gram was 4,500,000, while those stored in an ice-cooled refrigerator (46° F.) for the same period of time had a bacterial count of 107,000. As the bacterial count per gram of peas stored for four days on the coldest shelf of a mechanical refrigerator (32° F.) remained practically stationary, 5000 bacteria per gram, the advantages of storing the peas, when necessary, on the coldest shelf in a mechanical refrigerator are obvious. Since changes in peas begin above 10° F. it is advisable to keep frozen-pack peas in the cold storage locker until needed, unless the domestic refrigerator is equipped with a cabinet capable of maintaining a temperature of 10° or below.

Comparisons in quality were made between cooked frozen-pack, fresh, and canned peas. Frozen-pack peas were not only preferable to the fresh peas usually purchased on the market, but were unanimously rated higher than fancy-pack canned peas.

In the study of the economy in the use of frozen-pack peas, information concerning prices of fresh vegetables in other sections of the United States was obtained by means of questionnaires. It was found that the price of one half cup serving of frozen-pack peas was six cents, and fell between that of the same size serving of canned peas, which cost four cents, and the average cost of the same measure of fresh peas which cost eight cents from November 1935 to April 1936.

A STUDY OF THE USE OF FROZEN-PACK PEAS BY THE HOME CONSUMER

by

ZAIDEE ELIZABETH BONNEY

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APPROVED:

[redacted]

Professor of Foods and Nutrition
In Charge of Major

[redacted]

Chairman of School Graduate Committee

[redacted]

Chairman of College Graduate Council

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A STUDY OF THE USE OF FROZEN-PACK PEAS BY THE HOME CONSUMER

INTRODUCTION

As hunger has been designated one of the major impulses impelling humanity to arduous labor in order to appease its appetite, the ingenuity of the human race has been taxed to devise methods of preserving perishable foods from season to season. Of the methods gradually evolved by mankind to preserve all kinds of vegetables - drying, canning, cold storage, and freezing - the recently discovered frozen-pack process is said to be the best method known for the preservation of the qualities of the fresh product.

From the days in which the ancient Swiss Lake Dwellers used dried peas, to the present year when the consumption of canned peas in the United States was 480,000,000 cans and the consumption of fresh peas amounted to approximately 8,000 carloads, containing on the average 30,000 pounds each, people have been interested in finding ways of obtaining peas in the most desirable forms of preservation.

Although the freezing of vegetables commercially

began as recently as 1929, at present some canners on the Pacific Coast are using the frozen-pack method for all of their first class vegetable products which are adapted to the freezing process. Since the sweet garden peas as grown on the coast appear to be particularly adapted to the freezing process, a study of their use and preservation seemed imperative to be able to furnish consumers information about home storage possibilities and the best procedure to be employed in cooking frozen-pack peas. While numerous trade magazines carried articles of interest to the packers, there appeared to be nothing available to direct the house wives in the use and method of cooking frozen products.

There were several reasons for making a study of the use of frozen-pack peas by the home consumer: (1) to develop a standard method of cooking frozen-pack peas; (2) to ascertain the practicability of keeping frozen-pack peas in the home for a brief period of time before cooking; (3) to compare the cooked frozen-pack with the cooked fresh and canned peas; (4) to judge the relative economy of the use of frozen-pack peas. Laboratory experiments were carried on to determine information regarding the first three objectives. To obtain information on the economy of frozen peas data

were collected which gave lists of some fresh vegetables available in various regions of the United States from April to November, and the availability of frozen, fresh, and canned peas with costs.

REVIEW OF LITERATURE

Through the increasing interest in the importance of a balanced menu, it is believed that the typical American diet of meat, potatoes, and apple pie can be arranged through education to include more of the protective foods: milk, vegetables, and fruits (13). Not only has the consumption of fresh food products been greater in recent years, as is shown in the gradual increase of carlot shipments of fruits and vegetables in the United States, but the amount of canned vegetables and fruits has increased three or four times from 1899 to 1927 (53).

Among vegetable products, peas have long been considered a delicacy to be used freely in varying the menu during the season of local production, and they have also been employed in increasing amounts for that purpose when shipped in from other sections of the continent. Our neighbor Mexico shipped in 4200 carlots of green peas from 1930 to 1934. The increase in the consumption of fresh peas is also shown by the 2,707 carlot shipments of 1925 in the United States, growing to 6,868 by 1934. The expansion is further verified by the grand total of the aforesaid period, being 58,955

carlot shipments (76) (77). Moreover, peas are one of the three vegetables canned in largest quantities in our country, supplying a constantly increasing trade in sections where a trade has already been established (12).

The Use of Peas by Man Antedates Authentic Chronicles

Mankind's use of peas predates authoritative history. As is the case with some of the other common vegetables that have been used from time immemorial, the habitat of the original pea vine is unknown; and it is even difficult to distinguish between the different kinds of pulses used by humanity during the heyday of civilization of the ancient empires. The Greeks, for instance, seemed to use the same word interchangeably for lentils, chick-peas, lupines, vetches, and peas: the Romans used names of common vegetables for some of their well known family names. Thus, Fabius from "faba", the Latin for beans; Lentulus from "lenticula", the word for lentils; and Cicero from "cicer arietinum", the word for ordinary garden peas (34) (78). While the folk in ancient times seemed to have used only ripe dried peas for food, edible-podded peas with leeks and beans had become one of the three fresh vegetables known in England by the twelfth century (59). Just as dried

peas still retain a rather important place in our modern cuisine, the use of peas with edible pods has continued through the ages in many countries of the world today.

Between the time of using edible-podded peas and shelled peas, pea pods were cooked and eaten somewhat as artichokes are today: that is, the pod was dipped into a sauce, the peas were licked out, and the pod was then discarded. Green peas were not common even as late as 1700. One may read, "It is frightful to see persons sensual enough to purchase Green Peas at the price of 50 crowns per litron (little more than an English pint)". That this kind of expenditure prevailed at the French court may be seen by a letter written May 10, 1696:

> "The subject of Peas, continues to absorb all others; the anxiety to eat them, the pleasure of having eaten them, and the desire to eat them again are the three great matters which have been discussed by our Princes for four days past. Some ladies, even after having supped at the Royal table, and well supped too, returning to their own homes, at the risk of suffering indigestion, will again eat Peas before going to bed. It is both a fashion and a madness."

As popular as they were in France, it was not until after the restoration of Charles II that we read of shelled peas becoming a popular delicacy in England (34).

No other way of preserving peas than by drying was known until Appert received a prize for discovering the art of canning in 1809 (14). Although peas were canned in Baltimore as early as 1850, the amount of canned peas consumed by the American public was small, since commercial canning was not then a major necessity in supplying the nation's food (74). Nearly eight decades elapsed from the time peas were first canned in the United States until the next outstanding advance was made in the commercial preservation of peas: namely, freezing.

The Transition from Dried to Frozen-pack Peas Was Gradual

That cold was appreciated by the Egyptians for cooling beverages as early as 2500 B. C. is shown by the scenes in their frescoes, portraying pictures of slaves fanning porous jars of water (28). The Egyptians also used the cool night zephyrs to produce thin films of ice. This was accomplished by placing water-filled porous trays on slightly elevated beds of straw. As the night breezes circulated about the permeable receptacles, thin films of ice were formed on the surface of the water. At dawn slaves removed the ice to be used later in

chilling the beverages of the nobility (35). We discover in the writings of Hippocrates (about 400 B. C.) that ice was considered a luxury to be used for diverse purposes in medical practice (28). Somewhere near 1607 the Neapolitan physician, Tancredes, found that by mixing saltpeter and snow, cold became intensified. The temperature could be lowered by this means to such an extent that when a container partly filled with water was surrounded by the mixture, the water turned to ice (16). The first ice delivery to a home in the United States was made in 1802 (36). It has been estimated that only seventeen out of every potential hundred owners possess a mechanical refrigerator today (65). Though the progress in the use of refrigeration in the individual home may seem to have been slow, one needs to remember that more than as many milleniums as decades have elapsed since people in moderate circumstances could even buy ice. Ice was not the only commodity controlled by royalty. Salt was held to be almost sacred by the ancients. It was spoken of by Plato and Homer as "dear to the gods" or "divine" and was paid to Caesar's soldiers in fact or as a "salarium". Salt was not plentiful enough to be used in producing cold until the dawn of the twentieth century. Armour accounts for this lack by the fact that salt was heavily taxed in Europe

until that date.

In colonial days, when every family was nearly sufficient unto itself, the need of commercial refrigeration was not apparent; but, by the time Piper of Maine had made marked improvements in commercial refrigeration in 1861, inventions leading to the industrial era had begun to forecast the transformation of towns into cities, with their accompanying problems of food supplies (26). Although only a half a century has elapsed since New York received its first carload of vegetables shipped under refrigeration from Norfolk, Virginia, Birdseye believes that New York City could not exist at the present time more than from ten to fourteen days without cold storage food (59) (75). The production of artificial ice was necessarily increased in 1890 due to the greatest shortage of natural ice experienced up to that time (56). It remained for Tellier through his study of motors and compressed air to develop cold storage to such an extent that its service in modern living is insured (82). During the last fifty years the possible uses of refrigeration as a means of preservation have apparently just begun to be realized. The initial use of cold storage has in turn been partially supplanted by sharp freezing and then quick freezing.

Probably the first mention of frozen small fruits was made in a bulletin by S. H. Fulton of the Bureau of Plant Industry in 1907 (66). Although meat and fish were quick frozen about 1917, it was not until the late 1920's in the East and in 1929 in the West that vegetables were successfully frozen commercially (51) (83). Haslacher, of San Francisco, claims to have been the first to have frozen vegetables successfully; it was his process that was followed in the first commercial packing done by H. C. Hemmingway and Company of Syracuse, New York. Preservation of vegetables by freezing was an important milestone in the art of freezing foods on account of the difficulties encountered in keeping non-acid products. Although peas, lima beans, sweet corn, broccoli, asparagus, snap beans, mushrooms, spinach, squash, carrots, artichokes, and cauliflower have been successfully frozen, so far the peas are apparently the most promising of the frozen vegetables (75).

Successful Preservation of Foodstuffs by Freezing Led to Additional Research

As soon as the frozen food industry began to enter the commercial field, various men connected mainly with the government, or with the experiment stations of the

agriculture colleges, carried on extensive research work to aid the new industry. At present the United States Frozen Pack Laboratory, cooperating with the Western Washington Experiment Station, is carrying on an experiment of several years duration to determine the best varieties of peas for freezing in the Pacific Northwest. From the bacteriological standpoint the laboratory is also working on the significance of the maturity of raw material and the importance of handling the product rapidly before and after freezing (25). Moon, Caldwell, and Lutz have recently reported results of a two year study on eighteen varieties of peas grown at Arlington Experiment Farm near Rosslyn, Virginia. The varieties used were chosen largely for exceptional flavor, vigor, and yield, while a smaller number was selected for its importance commercially. In the study the peas were divided into five or six lots by screening. Each size obtained by the grading process was packed separately, so that the exact point might be determined at which loss of color, starchiness, and toughness of skin began. It was found that just two varieties of the peas tested, Thomas Laxton and Asgrow 40, were pleasing at all stages of maturity after freezing and after cooking (54) (55). There are a large number of other workers in the research field, but the results of their investigations.

will be mentioned under other phases concerned with the preparation, freezing, storage, and marketing of frozen peas.

Not only have investigations been conducted in the different states where products are raised that might be adapted to freezing, but various commercial plants have carried on research work to facilitate the preparation of their particular products. When Fulton first mentioned frozen food, sharp freezing, i.e. - storage in a room held at a temperature from 15° to -20° F. - had been the method followed since 1861 and this continued to be used until 1916 when Plank, Ehrenbaum, and Reuter demonstrated the advantages of rapid freezing of meat (75). As Birdseye explained his system in 1932, the process of quick freezing is less injurious to the cells in freezing meat than sharp freezing, because the zone of maximum crystal formation is passed through more rapidly and the elasticity of the cells allows the small ice crystals to be formed without rupturing the cell walls (10). Though the advantages of quick freezing appear to be dissimilar for meat and vegetable products due, some claim, to the inelasticity of the plant cell walls, it is probable that the majority of the investigators would concede that the rapid attainment of a temperature that prohibits the growth of microorganisms

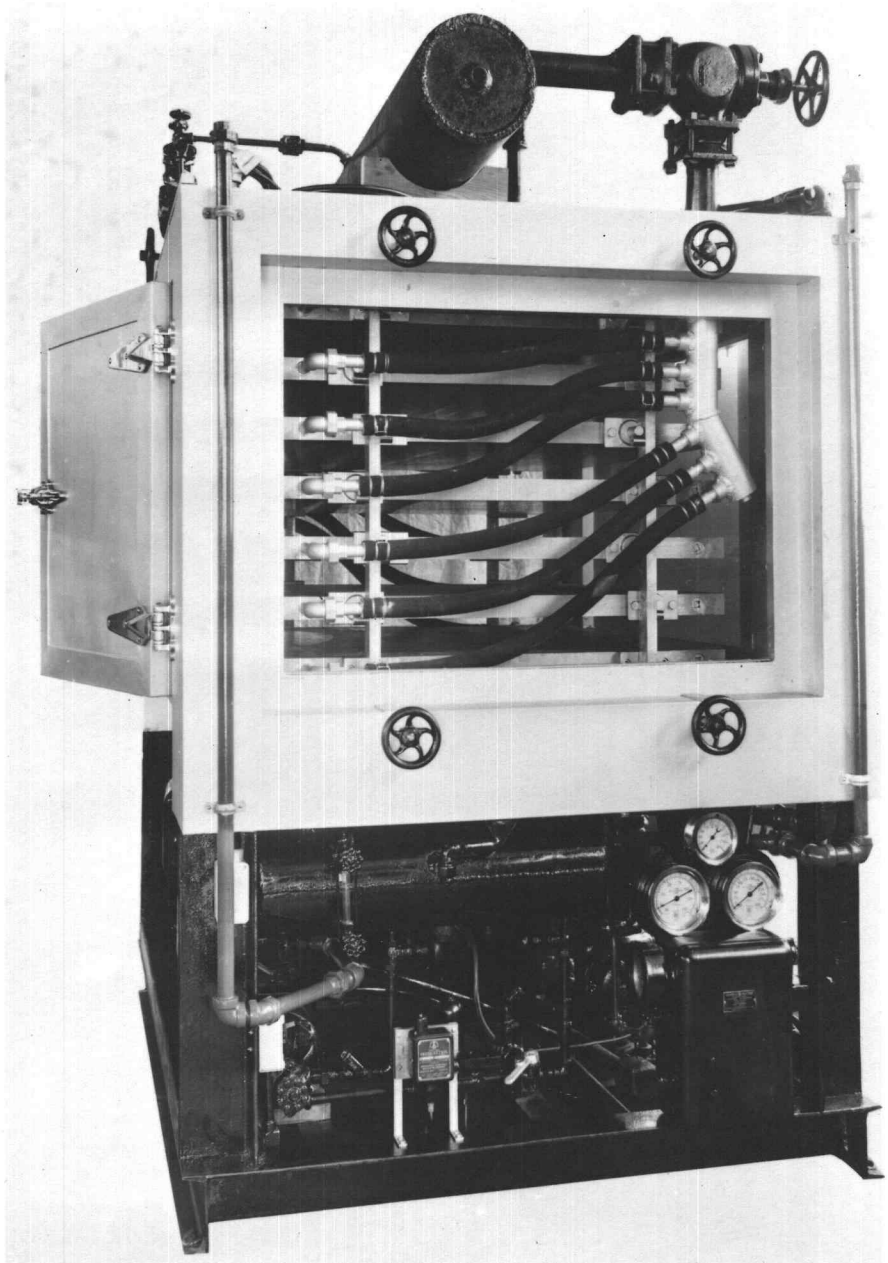
and practically inhibits enzymatic activity is desirable. The beneficial results hoped for from freezing are increased by correct scalding in that the peroxidase and catalase activities are checked for a time, and the abnormal respiration due to plant injuries from the vining machine are lessened (40) (42). The changes brought about by freezing are not completely understood. As to physical changes, while some claim that cell walls are injured, others have shown that the cell wall is not usually injured and death is "caused by coagulation of the protoplasm as a result of withdrawal of water from the cells due to ice formation in the intercellular spaces". It is known that freezing and thawing not only have a tendency to dehydrate vegetable tissues but also to toughen fibrous vegetables. The dessicated product tends to become toughened, probably due to the separation of chemically combined water. It is also known that vegetables are wilted during the freezing; and this wilting, according to Woodruff, may be due to the irreversible precipitation of the cell contents of the vegetable tissue and to the liberation of the water in the vacuoles (75).

Observations relating to the causes of flavor and odor changes show that enzymatic factors, i.e. peroxidase and catalase, which may have been inactivated

sufficiently to prevent unsatisfactory alterations in quality of the product, are still active (19). Kohman suggested that the change of flavor occuring in frozen peas might be due to anaerobic respiration (44). The factors causing deviations in color, flavor, and texture in peas stored for several weeks at a temperature ranging from 18° to 25° F. are not fully understood (19). In order to establish a more successful technique in the freezing industry, the physical and chemical changes involving alterations, due to respiration and micro-organisms, must be understood in their entirety.

Principal Systems Used in Freezing Vegetables

Of the several processes invented to freeze foods, the Birdseye System and the "Z" Process are the ones used most frequently for freezing vegetables. The Birdseye double-decker freezing machine has four flexible metal belts. In each case, the lower belt extends beyond the freezing unit and acts as a miniature "loading platform". The lower belts are thirty-six inches wide and the upper belts are forty-four inches wide in order that the refrigerant may flow off of the upper belts down into an insulated tank. The endless monel metal or stainless steel belts are not only used to



Courtesy of Frosted Food Sales Corp.

FIG. 1.— BIRDSEYE MULTIPLATE FROSTER.

convey the packaged food product through the freezing tunnel, but serve as a refrigerating contact, while a brine of a temperature of about -45° F. is sprayed on the reverse side of each belt. During the ninety minute period in which the product is being conveyed through the freezing tunnel, controlled pressure of several pounds per square inch is applied to maintain the original rectangular shape of the packages. The Birdseye multiplate froster (figure 1) is a later development. It consists of "a series of refrigerated metal plates placed one above the other in such a manner that they may be moved apart to receive products between them and then closed upon the products with any degree of evenly distributed pressure" (58). The plate froster being built as a unit, has several advantages: in that (1) it occupies less floor space; (2) it freezes the product more quickly at a higher temperature (25° F.); (3) it calls for a smaller capital investment; (4) it may be moved to different sections of the country as the crops mature; and, (5) it may be operated at room temperature anywhere that electric current and water are available (62).

The "Z" process for frozen-pack foods was invented by a leading Russian refrigerating engineer, M. T.

Zarotsehenzeff. The process may be carried on either in a cabinet, or in a tunnel in which pipes are fitted at intervals with atomizers, through which the refrigerating medium circulates. By means of the atomizer, refrigerated brine fog is sprayed on the product to be frozen and, while the particles of the refrigerant are very small, the heat transfer is quite rapid. The refrigerant is collected on the bottom of the tunnel or cabinet and recirculated by means of a pump (75). The "Z" process, next to Birdseye, is one of the most rapid freezing methods. It employs the freezing temperature most approximate to the cold storage temperature range (86).

One of the later developments in freezing peas is the preparation of "single frozen" peas, which may be brought about by freezing the vegetable on wire trays or belts in a blast of cold air (30). When trays are used, the cold blast may be blown into a vertical enclosure; when a belt is used, the product may be conveyed through a horizontal tunnel. In either event, each pea is frozen separately, like small green marbles, which can be poured from the containers as needed. Since any amount desired may be easily obtained, "single frozen" peas are particularly popular with the institutional trade (figure 2).

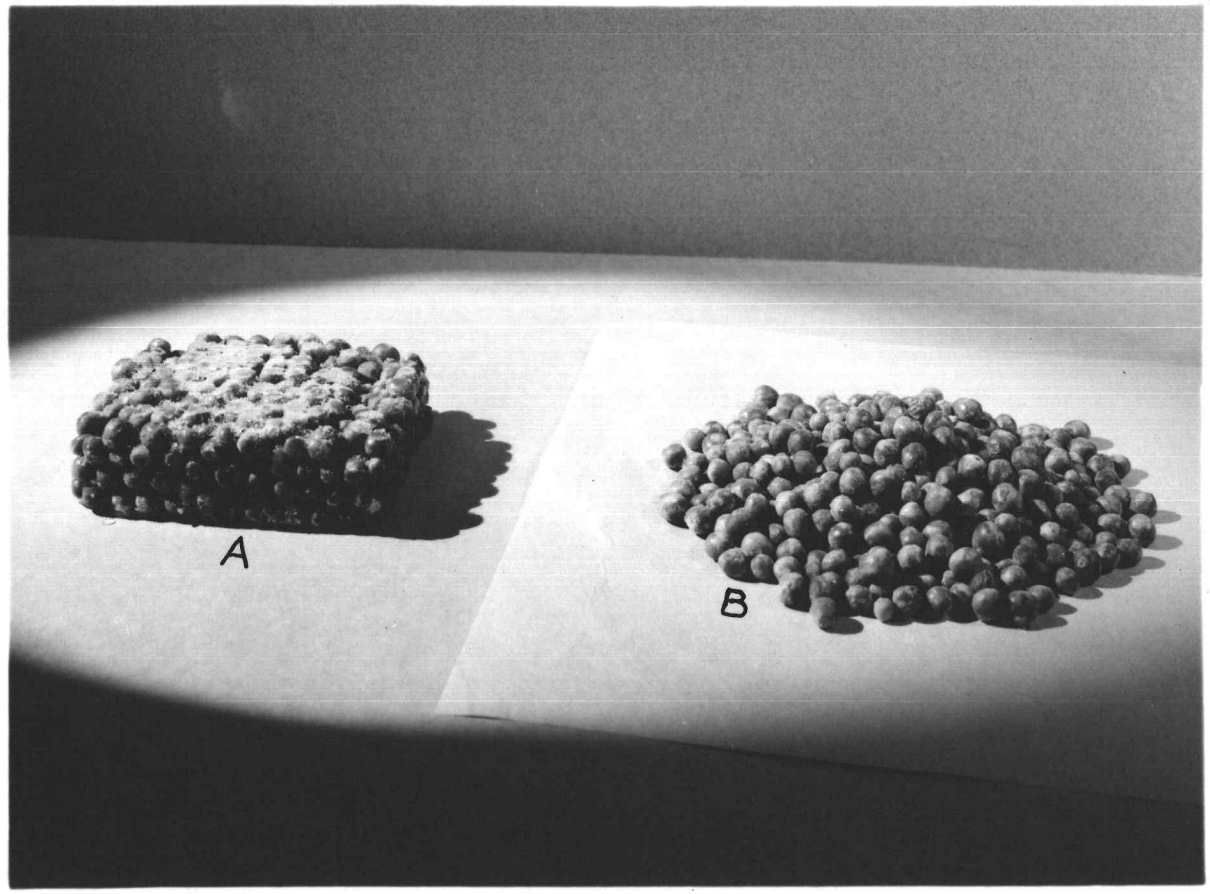


FIG. 2.— A. PEAS FROZEN IN CONTAINER.
B. "SINGLE FROZEN" PEAS.

Peas Preserved by Frozen-pack Process

The first consideration in preparing to freeze peas is the choice of suitable varieties, although climate and kinds of soil available are other important factors to be studied. In contrast to peas used for canning which are light colored and small, the peas for frozen-pack should be vivid green, somewhat larger and should belong to a sweet garden variety (75). A further matter to be taken under advisement is the potential food value, as Mack and Tressler have recently reported that the early small varieties of peas are better sources of vitamin C than the late large ones, and that the percentage of ascorbic acid decreases as the peas mature (49).

In the varietal studies being conducted by Diehl and Schwartze at present, it has been shown that some frozen-pack peas rating excellent before cooking, do not rank so well after a five minute boiling period. The reverse is true for others: that is, some which may rate good after freezing have been ranked excellent after a five minute boiling period (22). From a commercial standpoint, in selecting varieties to freeze, yield and ease of vining are additional points to be considered (20). Sometimes the production manager of

the plant furnishes seed to the farmers to be grown under contract and the crop is often harvested at one vining.

In the mechanical vining process, the epidermis is often bruised and it is believed that this breaking down of the peas' structure hastens the physical and chemical changes. Although the alterations begin as soon as the peas are harvested, the changes occur more rapidly after shelling (42). Fruits and vegetables continue respiration after harvesting, giving off carbon dioxide and taking in oxygen. Through respiration, Kertesz has shown that peas, held at 77° F. after picking, may lose approximately one-third of their sugar (75).

After hulling, the peas are washed to remove dirt, weed seeds, and immature peas known as "blisters". The amount of dirt removed, and the condition after washing is somewhat dependent on the kind of weather at the time of vining. At this point the medium sized peas are scalded for sixty seconds in water held at a temperature of 200° F. or above and cooled rapidly. Joslyn and Cruess, and Kohman, working independently, discovered the necessity of scalding and immediate rapid cooling to prevent "off" flavors in the frozen product after two or more months storage (41) (75). Since that time, a number of investigators have tried to determine just the

correct procedure for scalding. At first, some advocated as long as a six to eight minute scalding period. This resulted in a cooked flavor (2). In 1933 Joslyn and Marsh found a five minute heating at 190° F. necessary to inactivate peroxidase (40). In the same year, Kertesz reported the necessity for a two minute blanching in boiling water to stop respiration (43). Diehl reported that catalase in medium-sized peas was inactivated at 210° F. in 30 seconds, at 190° F. in 50 seconds, or at 160° F. in 105 seconds (18). In 1936 Arighi, Joslyn, and Marsh reported a satisfactory product was obtained by scalding peas for two minutes at a temperature of 176° to 194° F., in that they retained their good quality for over two years (1). During the same year Moon, Caldwell and Lutz obtained satisfactory results by varying the period of scalding from three minutes for the largest size peas (diameter 13/32") to one minute for the smallest sized pea (diameter 8/32"). (54). Probably the main function of a sixty second scalding period at 93.3°C., or above, for medium sized peas is: (1) to inactivate enzymatic action partially; (2) to cause color to "flash out" and become vivid green; (3) to check respiration; and, (4) to reduce viable microorganisms ninety-nine per cent. Diehl has demonstrated that if catalase is checked so that the

peroxide test shows that catalase is inactivated, at least temporarily, the peas will keep satisfactorily, if frozen promptly and stored properly (19).

To prepare a blended pack - that is, a pack that contains field run, with the exception of immature and over mature ones - the peas, which had been cooled immediately after scalding, are passed through a brine solution of controlled density to remove the overripe ones. After grading, the peas are conveyed along inspection belts in order that splits, broken skins, and any foreign material may be removed before packing. In a dry or liquid-pack, the peas continue to the automatic packaging machine before freezing; but in the "single frozen" method, the peas are frozen before being poured into containers.

Proper Containers Are Used for Frozen Vegetables

Certain points should be considered in choosing suitable containers for frozen vegetables. For commercial packers, the containers should be: (1) inert toward product, (2) non-collapsible during freezing, (3) capable of being set up mechanically, (4) able to exclude outside air, (5) inexpensive, and (6) able to create sales appeal for the consumer (38) (62).

Receptacles made from paper, glass, and tin have been considered for packaging frozen vegetables. For retail and wholesale trade, a well known commercial plant uses a wax box, known as the "Peters" type lock-end carton. The carton is lined with a moisture proof, water repellant cellophane and wrapped in a special glassine paraffined paper before freezing. The cartons come in ½ to 10 pound sizes, with the hotel trade usually taking the 2½ to 10 pound sizes (24). Paper cups and cartons, besides being available and inexpensive, have other advantages in that the material of the carton is tasteless and odorless and the contents freeze more quickly than in glass or tin containers (38). Glass containers are transparent, moisture proof, air tight, and suitable for the homemaker to use (85). While plain or lacquered tin cans may be used for frozen-pack, they have the same disadvantage as glass jars, in that the consumer normally expects canned goods to keep indefinitely. The possibility of this confusion by the retail trade appears to outweigh the advantages of being gas tight, easy to vacuumize, and able to exclude light (21). In regard to containers, Tressler states, "Distributors at an early date began to feel that if a package, completely different in every respect could be used, it would eliminate the above danger of mistaken

identity" (75). Among other types of containers, friction top closed cans are used by some packers for the institutional trade (figure 3).

Packing Methods Used in Packing Frozen Vegetables

Experimentally, the several methods used in preparing frozen-pack vegetables are the brine-pack, the water-pack, and the dry-pack. In the brine-pack in the west, the peas are covered with a 2% brine and frozen in air tight containers. The frozen brine also acts as a safety factor in shipping. To the trade, the advantages of the peas having a pleasing, plump appearance and better flavor after defrosting are outweighed by the following disadvantages: namely, (1) increased shipping costs, (2) expense of air-tight containers (necessary to prevent mold growth), and (3) the loss of 50% solubles if the peas are not cooked in the brine in which they were packed (19). With storage at 0° F. Moon, et al., observed that brine and dry-packs of the same variety were indistinguishable after cooking, whether tin or paper was used as container (54). In dry-pack, Diehl believes that the cells freeze first, and that this effects the palatability; but the advantages of reduced freight charges of lighter containers,

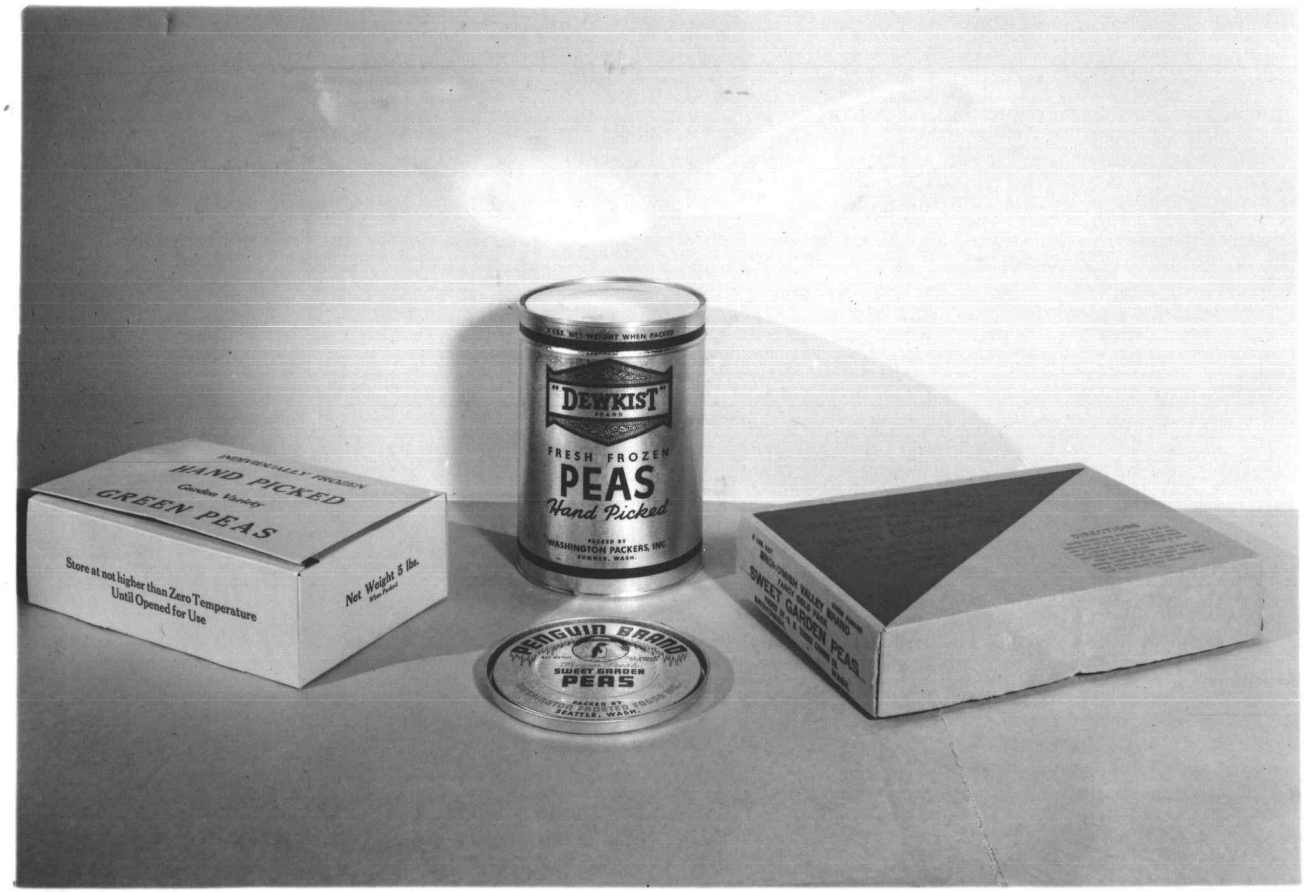


FIG. 3.– WHOLESALE CONTAINERS FOR FROZEN-PACK PEAS.

and of the product's tasting sweeter than when brine is used for packing cause most of the commercial packers to use the dry-pack method (17).

Frozen-pack Peas Have Certain Advantages over Fresh Peas

Frozen-pack peas have certain advantages over fresh peas which have been shipped in from a distance: the frozen products have been stored within six hours of harvesting (84). With such prompt storage, a good product picked at the right stage of maturity may be kept more nearly in its original condition than in any other known way. Kertesz has shown that peas change very rapidly after harvesting, particularly, when shelled and kept at room temperature (42). The consumer rarely obtains locally grown fresh peas in less than twenty-four hours after harvesting (84). California peas shipped in refrigerator cars held between 32° to 50° F., arrive in New York the eleventh day after harvesting (32). From a three year study at Cornell, the maximum storage period permissible for fresh peas, held at 32° F. was found to be two weeks (29). It has been found that loss of sugar may be retarded considerably when held at that temperature (60).

Besides better quality, frozen-pack utilizes perishable crops, thus making wider distribution of peas possible. 3,500,000 pounds of peas were frozen in Oregon and Washington in 1935 (83). As the peas are considered superior to the average fresh peas found in the city markets, the pea season is extended for those who can afford them (80). Transportation costs are less in that only edible parts are sent from point of production (64). Only 45 pounds gross, as against 125 pounds gross, need to be shipped to get the same number of servings (32).

Many studies on the nutritive value of frozen peas as compared to that of canned and fresh peas have not been started because the practical problems of marketing frozen peas had to be met first. The investigators may have felt that if Feller's studies revealed adequate retention of the unstable vitamin C, the loss of the other constituents might prove to be negligible. Feller's observations to date show that while frozen-pack peas contain less vitamin C than fresh peas, they contain nearly twice as much vitamin C as heated canned peas (27). This is shown in the following summary:

Vitamin C in Fresh, Frozen and Canned Peas

	No. of Samples	Protective Level Grams
Fresh peas, cooked	32	3.6
Frozen peas, cooked	40	4.6
Canned peas	13	8.8

In their study of Alderman peas, Diehl, Campbell, and Berry reported chemical analyses of No. 6 sieve peas. Their summary of the analyses reads:

> "No marked alterations in the dry matter, carbohydrates and ether extract resulted from the scalding of peas by live steam or boiling water for the customary short periods already indicated.
>
> Freezing storage of scalded peas packed without liquid at -20.6° and -6.7° C. (-5° and 20° F.) for a period of almost a year had practically no effect on the dry matter, starch, total sugar, acid hydrolyzable polysaccharides and ether extract.
>
> Freezing storage of scalded peas packed in 2 per cent sodium chloride brine at -20.6 and -6.7° C. (-5 and 20° F.) resulted in considerable losses in dry matter and total sugar, amounting to approximately 15 per cent of the former and about 40 per cent of the latter, calculated on a fresh weight basis." (19)

These results are shown in abbreviated form in table 1.

A dream has been realized in the distribution of fresh vegetables by the appearance of packaged frozen vegetables. Spoilage losses from the point of harvest to purchase by the consumer are reduced to nothing and

Table 1

Chemical Analyses of Second-Crop Alderman Peas, Raw or Scalded in Steam of Boiling Water, promptly Cooled to 55° F., Packed with 2 per cent Brine or without Liquid and Stored in Hermetically Sealed Cans in Air at -5° F. and -6.7° C. for 330 days. (Percentages in terms of fresh weights) (19)

Percentage composition on bases of fresh weight	Control unscalded	After scalding	Freezing storage 330 Days			
			Dry pack		Brine pack	
			-20.6° C. (-5° F.)	-6.7° C. (20° F.)	-20.6° C. (-5° F.)	-6.7° C. (20° F.)
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Peas scalded with steam						
Dry matter	22.7	22.57	22.34	22.50	19.05	19.30
Total sugar	7.00	6.88	6.80	6.80	4.20	4.12
Starch	2.04	2.03	2.04	2.03	2.04	2.01
Acid hydrolyzable polysaccharides *	6.41	6.38	6.40	6.38	6.20	6.22
Ether extract	0.424	0.423	0.420	0.426	0.424	0.422
Peas scalded with boiling water						
Dry matter	22.7	22.24	22.33	22.54	19.02	19.00
Total sugar	7.00	6.05	6.05	6.00	3.40	3.30
Starch	2.04	2.02	2.05	2.08	2.06	2.03
Acid hydrolyzable polysaccharides *	6.41	6.25	6.32	6.39	6.05	6.09
Ether extract	0.424	0.419	0.422	0.420	0.423	0.425

* Acid hydrolyzable polysaccharides include starch, but not total sugar.

the shopkeeper may figure profit just as in any other package goods without deducting from 3 to 5% for deterioration of the product (15). The consumer saves time in preparation, since it requires about five minutes to collect utensils and shell a pound of fresh peas, while the frozen-pack peas are ready to be put directly into the saucepan for cooking.

Factors Influencing the Success of Frozen-pack Peas

Though the early investigators did not indicate the varieties of peas used, it was soon noted that many kinds desirable for canning, were not adapted to the frozen-pack process. In canning, the chlorophyll is changed, due to the prolonged sterilization, while in frozen-pack, the brief scalding period brightens the green coloring which is present in the epidermis. Certain varieties of garden peas have been found adapted to frozen-pack. Among the one hundred odd varieties packed by Diehl in 1936, the following six were rated very excellent after freezing: Extra Early Gradus, Duplex, President Wilson, World's Record, Roger's Gilbo, and Teton (Thomas Laxton, wilt-resistant). Of the six, two were rated exceptionally good after a five minute

boiling period - President Wilson and World's Record. The other varieties which had especially high ratings after cooking were Duchess of York, Duke of Albany, and Alderman (22). Only sound, fresh vegetables should be used in preparing frozen-pack. Due to the equable climate in the Pacific Northwest, garden peas grow larger while still remaining sweet and not starchy, so that larger sized peas may be packed in the West than in the East.

As it has been observed that lactobacilli and "colon" organisms persist in peas for at least two years after freezing, sanitary control should be exercised in all handling of the peas before freezing (5). It is suggested that employees should pass medical examinations and that the city water supply should be pure (79).

Considerable research has been carried on relating to suitability of inexpensive containers for frozen-pack products. To achieve a successful frozen-pack product, the containers should protect the product from foreign cold storage odors (figure 4) and yet not react with the product (38). Diehl states that it has been found very important to have gas tight containers because of less danger of spoilage.

Commercially frozen-pack peas may be quick frozen in less than ninety minutes. The best industrial

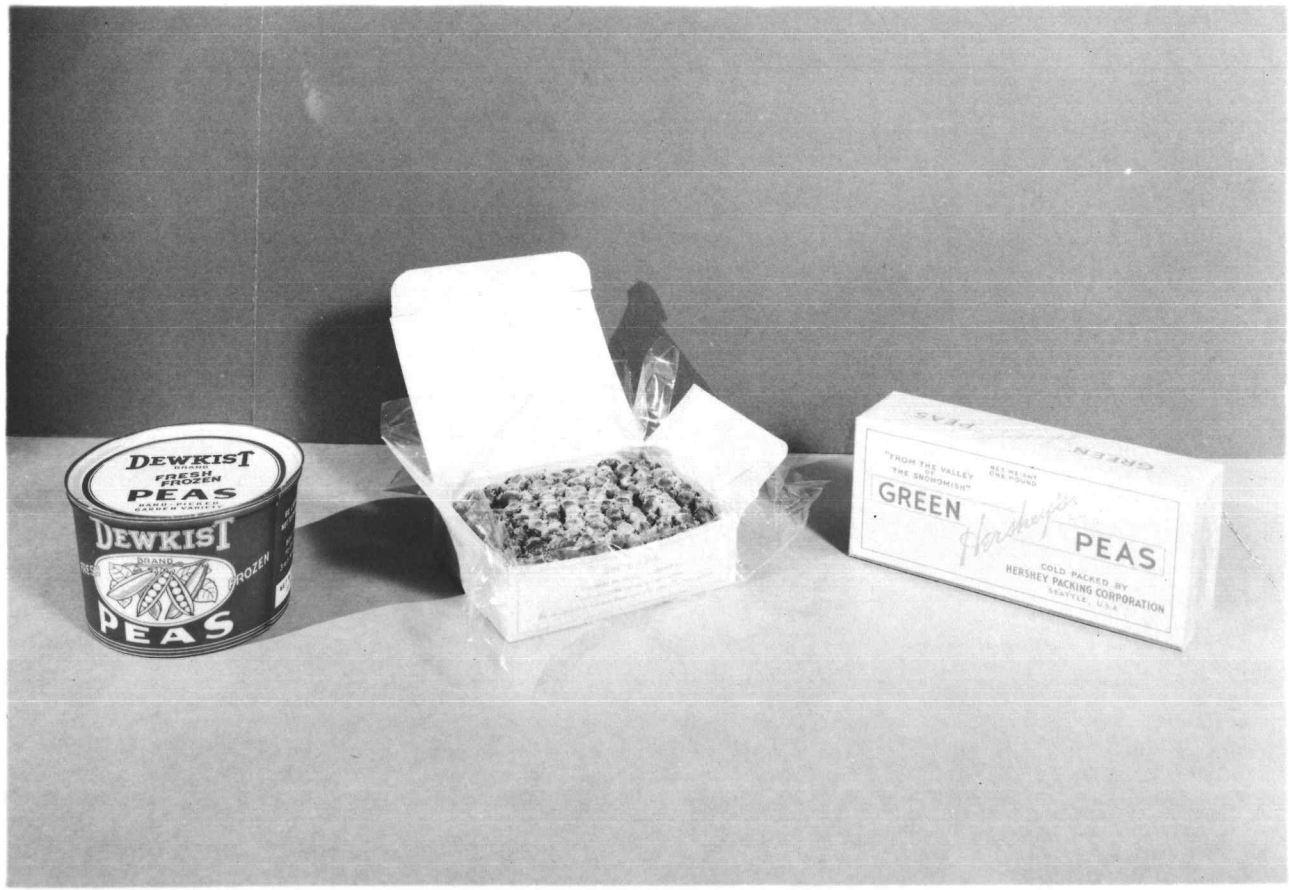


FIG. 4.– RETAIL CONTAINERS FOR FROZEN-PACK PEAS.

practice for long storage of frozen-pack peas advocates a storage temperature near -17.8° C. (0° F.) (19). Home frozen peas may be frozen in the individual storage lockers by arranging the containers so as to have free circulation of air about them to facilitate the freezing process (75). Research conclusions at the present time indicate that temperatures ranging from -5° to 10° Fahrenheit are satisfactory storage temperatures for small containers (85). Many commercial plants have a cold storage plant near, if not adjacent to their freezing plants. The first experimental packs of frozen vegetables were stored at -25° F., and they kept six months without prescalding. Until new methods of refrigeration are discovered, this temperature is not practical economically on a large scale and pre-scalding remains necessary (75).

Possible Rôle of Microorganisms in Frozen-pack Peas

As soon as frozen vegetables were sold commercially, some observers feared that the perishability of the product might not be recognized by the consumer (39). Fear of toxin developed by Clostridium botulinum, in some vegetables canned in the home led to special

studies in a number of laboratories concerning the development of botulinus toxin in frozen products. Straka and James conducted a series of tests on twelve hundred containers of frozen peas. The investigation included four types of containers, three methods of inoculation, two methods of packing, and four methods of defrosting. Before freezing, the peas had been inoculated with buffer suspensions of dried Clostridium botulinum spores. They reported that no toxin developed in peas which were examined immediately after defrosting, and none developed in those defrosted and held for three days in the ice-cooled refrigerator (67). The results with all the types of containers showed that toxin was obtained only in the defrosted peas that had been held at room temperature, ranging from 80° to 90° F. from three to three and a half days, and that all of these peas were definitely spoiled (68).

In their further studies with frozen vegetables, Straka and James reported results obtained when defrosted peas were held at ice-box temperatures for a longer period than three days, and results obtained when defrosted peas were held at room temperature for a shorter period than three days (69). Quoting these authors, they state:

> "A total of 198 samples of frozen peas in various types of containers were examined as follows:

1. 83 uninoculated controls. 33 defrosted and held at 80° F. for two days; 20 defrosted and held at 60° F. for three days; and 30 defrosted and held at 50° F. for seven days.

One of these controls, defrosted and held at 50° F. for seven days, gave positive evidence of a weak toxin.

2. 15 containers receiving a dilute inoculum. Defrosted and held at 80° F. for two days; and none of these samples gave any evidence of toxin.

3. 100 containers receiving a concentrated inoculum. 30 defrosted and held at 80° F. for two days; 15 defrosted and held at 60° F. for six days; 15 defrosted and held at 60° F. for three days; 30 defrosted and held at 50° F. for seven days; and 10 defrosted and held at 42° F. for seven days.

Of these samples, 9 gave definite evidence of toxin; 6 had been held at 80° F. for two days and 3 at 50° F. for seven days". They conclude: "When peas preserved by freezing are properly handled there is no danger of botulism. They should not be held at room temperature after defrosting, and leftover portions should be well refrigerated and thoroughly cooked before consumption."

Berry reported, in 1932, that bacillus botulinus did not grow below 31° F. Lactobacilli organisms found to be present after two or more years storage of peas at 15° F. form one or more per cent of acid in two or more days at room temperature, this acidity is considered to be unfavorable to clostridium botulinum, with its range of growth between pH_6 and pH_8 (3). In the experiments concerning microbial growth in frozen foods, Berry used 2700 (1# containers) of strawberries, 1300 of raspberries, 360 of cherries, 800 of peas, and 650

of string beans. The vegetables were both scalded and unscalded, packed in or without brine, in cups or vacuumized and unvacuumized cans. This investigator concludes:

> "Of twenty cans of blanched peas and ten cans of unblanched string beans inoculated with Cl. botulinum spores fifteen to eighteen months previously, none proved toxic either on thawing or on standing at room temperature for from three days to three weeks. Likewise, four "control" uninoculated cans of peas and four of beans of the same pack failed to develop toxin over a similar period. To date Cl. botulinum has not with certainty been recovered from inoculated material. It should be noted that positive results in similar experiments have been reported by other workers." (7)

Similar conclusions supporting the freedom of danger from clostridium botulinum in frozen-pack foods, cooked before or immediately after defrosting, were reached by Tanner (71), Wallace and Park (79), Fellers (26) and others.

Growth of bacteria, yeasts, and molds which is very active between 70° to 80° F. is lowered as the temperature is lowered until the growth is practically negligible for vegetables at 10° F. (75). Lochhead and Jones reported that a marked decrease in microbial counts occurred at the beginning of storage, but that later they declined slowly, it at all. The authors state that: "After nine months storage at -17.8° C. (0° F.)

frozen vegetables may contain appreciable numbers of microorganisms. Development of microorganisms is appreciable at 5° to 10° C. and enormous at room temperature." (46). Similar conclusions concerning the reduction of viable microorganisms under comparable storage conditions have been reported by Prescott et al., (63), Tanner (72), and Berry (3).

Since it has been shown that the development of microorganisms is appreciable at the usual temperature range of mechanical refrigerators, long storage in the home or retail store (appendix, table 21) is not possible unless a special cold storage compartment with a temperature of 10° F. or below is provided. Directions on the package for keeping peas are misleading for the housewife because they state that peas can be kept as long as they remain solidly frozen. Though Prescott reported 46° to 59° F. to be the lower limit for growth of bacteria except those tolerant to cold, the frozen product must be stored at a temperature much lower than freezing (32° F.) to escape deterioration from cold tolerant bacteria and molds. Haynes, a British investigator, showed that while there were many microorganisms active between 30° and 32° F., the number decreased markedly by the time 20° was reached. Berry has reported 18° to be the critical temperature for

growth of molds, but storage even of acid fruit should be below that point for safety.

Many harmful changes occur in the zone below freezing and above the temperature that allows mold growth. Among the few spoilage factors that have been determined it has been shown that: (1) molds and cold tolerant bacteria of pseudomonas and flavobacterium species will grow in peas packed in non-airtight containers at 25° F., and (2) certain bacteria of lactobacilli species will grow in peas packed in air-tight containers at the same temperatures (4).

Fortunately the changes occurring when peas are kept for too long a period of time at unsuitable temperatures furnish organoleptical evidence: the attractive vivid green color assumes a yellowish cast, the growth of the lactobacilli causes a sour odor, and anyone familiar with frozen peas would consider the product to be wholly inedible. Commercial companies store frozen-pack peas at 0° F., but refrigerating companies furnishing individual locker space usually maintain the temperature at about 10° F. In general, it may be stated in relation to storage temperatures that the lower the temperature the longer the products may be held in storage without noticeable change (8).

Marketing Frozen-pack Peas

Shipment of frozen-pack products is carried on by means of refrigerated cars and trucks. The packaged food, packed and sealed in inexpensive packing cases of corrugated cardboard boxes, is transferred from 0° F. storage to the same temperature in pre-cooled refrigerated trains for transcontinental shipments. With the exception of a vacuum, the pockets of dead air in the corrugated box have been found to be the most efficient insulation known (50). In fact, sealed cartons with four liners can be used for shipping short distances without additional refrigeration. The Pacific Fruit Express built two hundred improved refrigerator cars in 1931 to care for the frozen-pack products of the Pacific Northwest. In recognition of the smaller retail packages, the cars were made larger to allow free air circulation. While the cars were also adapted for general refrigeration, the development of the frozen-pack industry must have seemed to be assured in the minds of the railroad executives, as the Northern Refrigerating Lines Incorporated built fifty new big refrigerator cars to be used on the Northern Pacific Railroad about the same time. Salt and ice having low initial cost are used for cooling the heavily insulated refrigerator cars (81).

At one time, some silica gel refrigerated cars were used; but this absorbent proved unsatisfactory, since it disintegrated in hot weather (75). Although dry ice is too expensive to use in refrigerated cars, its use is practical in the better insulated trucks. Trucks, refrigerated with solid carbon dioxide, have the advantage of low deadweight load with a high capacity for pay load as well as a temperature range from 32° to -30° F. (31).

Since there had been some prejudice against cold storage food, one of the first national companies to pack frozen products for retail trade decided to put on an educational sales promotion campaign in Springfield, Massachusetts. Selected stores were equipped with special display cases, which were capable of being held at a low temperature. The week's campaign was considered successful in that it was reported that eighty per cent of those who bought during the campaign, continued to purchase frozen-pack products (64). At the beginning of 1936 the same company that promoted the sales campaign in Springfield had frozen products handled in 1200 stores in New England, New York, and New Jersey.

Refrigerated cabinets that will hold a temperature of 10° F., or lower, with only slight fluctuations, are necessary in storing and dispensing frozen-pack foods

for retail trade. At first, frozen foods were stored in ice cream cabinets. The first especially designed cabinets were built with a display section, so that the public might see the new product in the case. Many difficulties were caused by frost forming on the inside of the four windows and by temperature fluctuations on account of the doors being opened. Besides mechanical difficulties, the cost of the first triple plate insulated display cases was between $700 and $1500. Recently a $300 case (figure 5) has been constructed which uses lithographed cards instead of real foods for display. Not only has the initial cost of the cabinet been reduced, but the operating cost has been materially decreased (61).

Many of the companies engaged in the frozen-pack industry only, supply the institutional trade as hotels, ships, railroads, and hospitals. It has been estimated that a third of the nation's food is used by institutions, which are already equipped with facilities for refrigeration. The public as a whole are not prepared to accept frozen products, presumably on account of the early mistakes made in the retail handling of fish and berries. It might have been to get away from ill-repute connected with the expression "cold storage foods" that the term "frosted" was invented. The word is a pleasing

Courtesy of Frosted Food Sales Corp.

FIG. 5.— A TYPE OF REFRIGERATED CABINET USED IN RETAIL STORES.

one, and it is believed that if the firms freezing fruits and vegetables continue to be very careful of the quality of the products marked "frosted", in time the term will be recognized as indicating a product of high quality (75). Before the use of "frosted" foods can become general, many more adequately refrigerated cars and trucks, cold storage warehouses, and retail stores equipped with low temperature refrigerated cabinets must be available (73).

EXPERIMENTAL

In making a study of the use of frozen-pack peas by the home consumer, it seemed important to conduct some preliminary tests before definitely determining a standard of procedure. Hence some general observations about the methods of handling frozen-pack peas are reported here. This introductory survey showed the need for information concerning the methods of defrosting, the storage of frozen-pack peas in the home, and the effect of different factors involved in cooking the frozen vegetable.

Preliminary Tests

Frozen-pack peas used. The peas used in this study were ungraded frozen brine-pack peas from the experiment station laboratory, ungraded frozen brine or dry-pack peas from the United States Frozen Pack Laboratory in Seattle, and graded frozen dry-pack peas from the Frosted Foods Sales Corporation of Hillsboro, Oregon. In the first instance, a sack of peas had been purchased at a local store when the season for homegrown peas was nearly over. The last lot was grown under contract and harvested at the discretion of the production manager.

The varieties of peas frozen were unknown, except those from the Frozen Pack Laboratory, where Laxton Progress, Strategem, and Telephone peas were packed.

Seventeen cans of brine-pack and forty packages of dry-pack were used during the preliminary tests. The products to be tested were kept in a cold storage locker, upon arrival in Corvallis, until removed as needed to a mechanical refrigerator in the Home Economics Building.

Defrosting methods. To remove the brine-pack peas from a can two methods were used, namely: tap water (145° F.) was allowed to run on the can for thirty-five minutes, or a can of peas was left overnight in a mechanical refrigerator which had a temperature range of 35° to 40° F. In the first case, a solid ball of frozen peas remained in the center of the can, and in the second instance, the peas still retained the shape of the can for a short time after their removal from the container. Dry-pack peas, frozen in cans, were thawed under hot tap water and dry-pack peas frozen in Peters' type cartons were defrosted at room temperature.

Home storage of frozen-pack peas. To test home storage facilities, containers were placed in an ice-cooled refrigerator and in a mechanical refrigerator. In the latter, the brine-pack peas were defrosted in three days when placed on the lowest shelf; while the

dry-pack peas placed in the defrosting tray, remained frozen for ten days, the time limit of the experiment. The temperature range in the mechanical refrigerator was 28° to 35° F. The results obtained by leaving the packages of peas in the refrigerator using ice were unsatisfactory because the room temperature was 85° F., and an ice-cooled refrigerator will have a temperature in food storage compartments only 20 to 30 degrees lower than the room temperature (36). Studies made by the United States Bureau of Home Economics of the Department of Agriculture show that when perishable foods are to be kept over forty-eight hours, they should be stored below 45° F. (23).

Penetrometer test. The possibility of using a penetrometer to determine the "doneness" in cooking frozen peas was tried. Neither the needles accompanying the machine available, nor the trial ones made at a metal shop could be used. The result showed that, "limitations can be expected in instances where the nature of the material and the texture at doneness result in such rapid penetration, even by larger needles, that the time cannot be measured accurately with a stopwatch." (70)

Cooking method. The procedure used in these preliminary tests was to follow the printed directions

given on the packages of commercially packed peas. The brine-pack peas were entirely thawed before boiling in their own preheated packing liquid to prevent fifty per cent loss of their solubles (19).

Comparison of cooked peas. To obtain the opinions of a group about cooked frozen-pack and green peas during July, four frozen brine-pack cans, six frozen dry-pack packages and two lots of green peas were cooked for a class in marketing. The first choice was for the graded, frozen dry-pack peas, which the majority characterized as being "very good", "fresh", "sweet", "tasty", and "tender". While the ungraded dry-packs were occasionaly rated "good", they were more often scored as "firm", "slightly hard" or as having a "peculiar but pleasant flavor". The ungraded brine-pack peas when heated in brine, were described as being "slightly tough", or "not very sweet". However, when the latter peas were cooked in water, they were marked "hard", "raw", "skin slightly tough", or "slightly starchy".

The fresh peas were scored the lowest on the list as they were designated as being "hard, firm, poor flavor", "not young", "dull, bitter, strong", "slightly desirable", "fair, canned flavor", "tough", or "firm, but not very tasty".

To obtain the opinions of individuals about frozen-

pack peas during other seasons of the year, five home economics teachers were asked to judge cooked frozen and fresh peas both in April and June. Four out of five judges rated the cooked frozen peas higher than the green peas purchased at the best vegetable market in the city. Green peas grown in the home garden and served to the connoisseurs within half an hour from removal of the vines were rated first.

DEVELOPING A STANDARD FOR COOKING FROZEN-PACK PEAS

In this study the attempt was made to give the home maker a standard method of cooking frozen-pack peas. Recent experimental studies have shown the home maker how to cook green vegetables satisfactorily, but no general directions resulting from experimental studies for cooking frozen-pack peas have been available to the home maker. The following tests were set up for this purpose.

Equipment used. The cooking tests were made on a medium sized burner of an automatic electric range. A thermometer and two stop watches were used to check temperature and time of cooking. For temporary storage of the frozen product, a modern electric refrigeration, in the experimental laboratory was used. Saucepans for the cooking tests were selected from those a home consumer might consider suitable to use when cooking two cups of peas. With one exception, the material of the saucepan used was high grade enamel. Other untensils, used in the tests, were standard measuring cups, spoons, and scales.

Procedure. The cartons, each containing twelve ounces of dry frozen-pack peas, were left in the ice cube compartment of the refrigerator until the utensils had been collected and the water was boiling. The peas were then removed from the carton and placed in a saucepan. A half teaspoonful of salt was added and three-fourths of a cup of boiling water was poured over them; the pan was placed on the hot electric plate and the time recorded. The saucepan was left uncovered to allow part of the volatile acids to pass off with the steam and the temperature and time were noted when the water began to boil anywhere in the pan (48). During the pre-boiling period, the peas were stirred at intervals to effect more even distribution of heat. The peas were boiled for the period of time decided upon for the particular experiment. As soon as a rolling boil appeared over the surface of the peas, the switch was turned to medium heat (52). Upon expiration of the boiling period, the contents of the pan were poured into a white china vegetable dish for judging.

Judging cooked peas. After the peas were cooked, they were judged by two or more individuals. A sample form of the card used to score cooked peas follows.

Record Card for Cooked Frozen-pack Peas

Sample No. _____ Date _____

Judged by _____

Qualities	5	4	3	2	1
Appearance	Plump (well filled out)	Slightly wrinkled	Concave on one side	Somewhat collapsed	Collapsed
Color	GY-G /	GY-G /	GY-G /	GY /	GY /
Texture	Firm yet tender	Less firm but sufficiently tender	Soft	Somewhat mushy	Mealy
Flavor	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable
Conclusions	Excellent	Very good	Good	Fair	Poor

Comments:

Numerical score. A numerical score of one hundred was possible, with a distribution of points as follows; ten for appearance, twenty for color, thirty for texture, and forty for flavor. In obtaining numerical score, 10 was allowed for appearance when the judge checked it under column "5"; 90% of 10, or 9 when the judge checked appearance under column "4"; 80% of 10, or 8 under "3"; 70% of 10, or 7 under "2"; 60% of 10, or 6 under "1". That is, if a sample was checked for

appearance under "4", color under "3", texture under "2", and flavor under "4", the score would be 90% of 10, or 9 for appearance; 80% of 20, or 16 for color; 70% of 30, or 21 for texture; and 90% of 40, or 36 for flavor, making a total score of 82. A scored record card is given in the appendix.

Color. In judging color, the abridged edition of Munsell's Book of Color was used for recording the color formula of hue, value, and chroma. It was found helpful in deciding color designation: (1) to stand away from the table to get mass effects of light and dark; (2) to put a spoonful of peas from various lots on a white china saucer to see if it were possible to detect differences in color between them (57).

Peas. The peas used in the cooking tests were packed by a commercial firm. The weight on the package was exceeded by nine grams (an average of four packages). In volume, the peas measured two cups or a trifle over. Two cartons, forty-eight packages to a carton, were used in the cooking tests (figure 6).

The following experiments were used in developing a standard of cooking frozen-pack peas. Various factors were considered which might influence the end product. The first experiment was set up to find out whether the size and shape of the cooking vessel was a

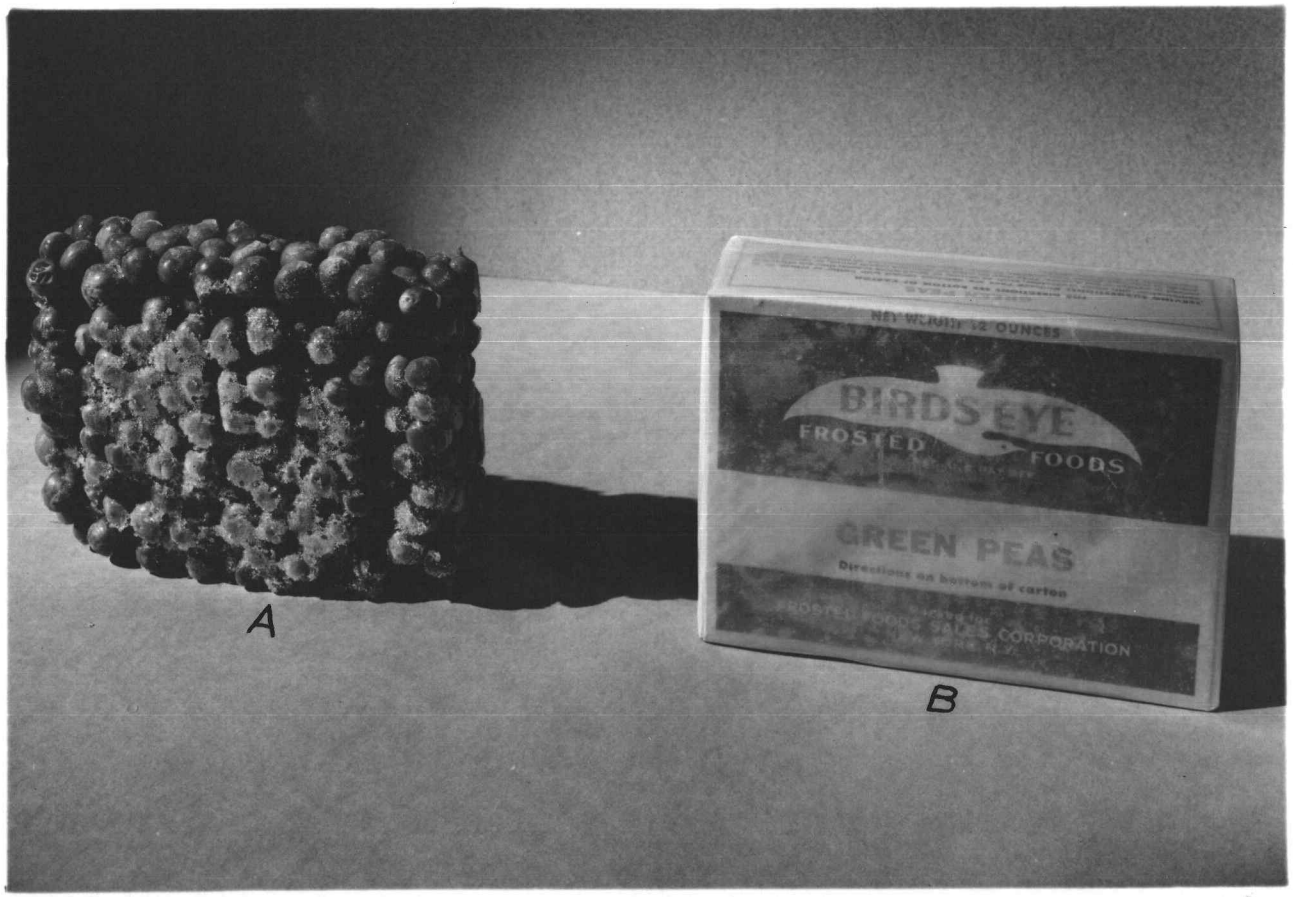


FIG. 6.— A. FROZEN-PACK PEAS.
B. PETERS' TYPE LOCK-END CARTON WRAPPED WITH GLASSINE PAPER.

factor to be considered.

I The Effect of Depth and Width of Pan on Cooking Peas

To determine the effect of cooking frozen-pack peas in a shallow or deep pan, five parallel experiments were performed. The measurements of the pans were as follows:

	Deep Pan	Shallow Pan
Inside Diameter	5 3/4"	7 1/8"
Inside depth	5 1/8"	3 5/6"
Capacity	9 2/3 cups	9 cups

Results. In descriptive terms, the cooked frozen-pack peas were pronounced pleasing in appearance, with their flavor and tenderness resembling that of home grown garden peas. The color ranged from green-yellow-green 6/8 to green-yellow 5/8. The results obtained are shown in table 2.

Table 2

Average Scores for Peas Cooked in Shallow and Deep Pan

Utensil	Number of tests made	Time boiled (min.)	Average total cooking time (min)	Average score
Deep pan	9	5'	10' 20"	95.5
Shallow pan	9	5'	10' 28"	94.5

Conclusion. The results obtained in cooking frozen-pack peas in deep and shallow saucepans under standard conditions, indicated that the width or depth of pan suitable to cook one pint of peas, did not affect the color or time of cooking nor the quality of the product to any significant degree.

II The Effect of Time in Cooking Peas

To ascertain the effect of time in cooking frozen-pack peas, the peas were boiled one, two, three, four, five, and twenty minutes.

Table 3

Average Scores in Time Tests

in Cooking Peas

(Arranged According to Desirability Rating for Flavor)

Number of tests made	Time boiled (min.)	Average total cooking time (min.)	Average score	Color	Comments
3	4'	9' 42"	95	GY-G 6/8 to 6/10	Rated very desirable in flavor and texture
4	3'	9' 2"	94	GY-G 5/8 to 6/10	Rated very desirable in texture and flavor
6	5'	10' 14"	91	GY-G 5/8 to 6/10	Rated slightly overdone by majority of judges
3	2'	7' 37"	81	GY-G 6/8 to 6/10	Rated underdone
2	1'	6' 30"	81	GY-G 5/8 to 6/10	Rated underdone
2	20'	25' 43"	65	GY 6/6 to 6/8	Rated too mushy, shriveled, and mealy

The results arranged according to desirability rating for flavor are given in table 3.

Conclusion. As indicated by the scores in table 3 the most satisfactory periods of time for boiling were three or four minutes.

III The Effect of Using Varying Amounts of Water in Cooking Peas

In determining the effect of cooking twelve ounces, two cups, of frozen-pack peas in different amounts of water, one-half cup of water was compared with three-fourths cup of water. In the method used in this study, it seemed undesirable to try less than one-half cup of water. However, if the peas had been defrosted before, cooking it might have been possible to have used a smaller amount of water. The average scores obtained in cooking peas in different amounts of water are shown in table 4.

Table 4

Average Scores for Varying Amounts of Water

Amount of water	Number of tests made	Time boiled (min.)	Average total cooking time (min.)	Average score
1/2 c.	2	4'	8' 26"	92
3/4 c.	3	4'	9' 41"	91

Conclusion. Using one-third less water in cooking peas did not effect the final score and therefore it was assumed that a range of one-half cup to three-fourths cup of water, for two cups of peas, would not effect the product. The minimum amount of water would probably be used if the homemaker intended to add cream rather than butter for flavor.

IV The Effect of Tap and Distilled Water Used in Cooking Peas

To compare the effect of cooking frozen-pack peas in Corvallis tap water (average pH 7.1) with distilled water, parallel experiments were performed. The results presented in table 5 are averages of the five tests.

Table 5

Average Scores for Tap and Distilled Water

Kind of water	Number of tests made	Time boiled (min.)	Average total cooking time (min.)	Average score
Distilled	5	4'	10' 5"	96
Tap	5	4'	10' 1"	96.5

Conclusion. As the judges decided that there were no perceptible differences in color, appearance, texture, or flavor when frozen-pack peas were cooked in Corvallis tap water and distilled water, tap water was used in the remaining cooking tests.

V The Effect of the Time of Adding Salt in Cooking Peas

To determine the best time to add salt, in cooking frozen-pack peas, one-half teaspoonful of salt was added: (1) to the peas before placing on the electric plate to cook, and (2) upon removal from the electric plate at the close of the cooking period. The results are recorded in table 6.

Table 6

Average Scores for Peas Cooked with or without Salt

Salt in cooking water	Number of tests made	Time boiled (min.)	Average total cooking time (min.)	Average score
1/2 t.	2	4'	9' 8"	98
0	2	4'	9' 12"	93.5

Conclusion. The samples were judged the same in

color and appearance. For flavor, the numerical score average showed that there was some advantage in adding the salt before cooking (45).

VI The Effect on Time of Cooking Peas in Pans of Different Material

To determine the effect on time of cooking frozen-pack peas in saucepans of different materials, high grade aluminum and enamel saucepans were used. The measurements of the pans used were as follows:

	Enamel Pan	Aluminum Pan
Inside diameter	6 5/8"	7 1/2"
Inside depth	3 3/4"	3 3/8"
Capacity	2 qt.	2 3/16 qt.

The results are given in table 7.

Table 7

Average Scores for Peas Cooked in Enamel or Aluminum Pans

Utensil	Number of tests made	Time boiled (min.)	Average total cooking time	Average score
Enamel pan	2	4'	10' 10"	98.5
Aluminum pan	2	4'	10' 26"	99

Conclusion. The difference in the total cooking

time being negligible (sixteen seconds), it was decided to continue the use of an enamel saucepan.

VII The Effect of Defrosting Frozen-pack Peas before Cooking.

Two packages of frozen-pack peas were opened, allowed to defrost at room temperature, and then cooked. One package was cooked without defrosting, for comparison in quality.

The time required for defrosting and the numerical scores are listed in table 8.

Table 8

Average Scores for Frozen-pack Peas Defrosted and Not Defrosted before Cooking

Temperature of room	Average time required to defrost peas	Number of tests made	Time boiled (min.)	Average total cooking time (min.)	Average score
80° F.	5 1/12 hrs.	4	4'	7' 13"	92
	0 (control)	1	4'	8' 45"	92

Conclusion. The peas which were defrosted before cooking were judged slightly more collapsed in appearance

than the control. The color, texture and flavor appeared to be the same in all cases and the judges decided that there was no advantage in defrosting frozen-peas.

Discussion

In the attempt to give the homemaker a standard method of cooking frozen-pack peas, an effort was made to determine a procedure that would not only retain the nutritive value, but would also preserve the attractive color, texture and flavor of the product. Fortunately, these aims dovetail into each other as overcooking causes irreparable losses in appearance and research has shown losses in food values. Research workers in the field of experimental cookery, have shown that chlorophyll is effected by heat, the length of time of cooking, and the hydrogen-ion concentration of the water. Among other variants, these points were considered in developing a standard for cooking frozen peas (47).

Chlorophyll. While the green pigment of peas, chlorophyll, is practically insoluble in water, it is liable to be changed to phaeophytin by the acids liberated from the vegetables during the cooking process. As phaeophytin produces an unattractive, olive colored

product, it has been found advisable to cook green vegetables in uncovered utensils to permit part of the volatile acids to escape with the steam (47). To determine if too great a depth of peas would have the same deleterious effect as cooking with the utensil covered, peas were cooked in saucepans of different depths. In table 2 the results signify that with the amount of peas the depth of the saucepans had a negligible effect.

Time. The length of time of cooking is one of the three factors determining the extent of the decomposition of chlorophyll. Diehl, in his study of frozen Alderman peas, found that the change in color began after a five minute period of boiling (19). As it was demonstrated that a three or four minute boiling period was sufficient to attain optimal results in palatability when cooking frozen peas (table 3), the danger of decomposition of chlorophyll from long exposure to heat was easily avoided. Trying saucepans of different materials or using less water decreased the period of cooking only a fraction of a minute and according to the scores (table 4,7) this slight reduction of time was of no material consequence. Peas cooked just before the time of serving and not held hot for an additional period of time retained their vivid color.

Salt. In a series of experiments carried on by Lanman and Minton, it was found that: (1) the percentage loss of ash from peas was less when salt was added before rather than after cooking; (2) the texture and flavor of peas were best when salt was added before cooking; and, (3) addition of salt after the first half of the cooking period gave relatively a better flavor than when salt was added at the end (45). In frozen-pack peas, the texture has been already changed during the freezing process, and so no difference in texture was noted by the addition of salt at various times during the cooking period. As reported in table 6, the flavor appeared improved by adding the salt before rather than after the peas had been cooked.

Heat. The disintegration of chlorophyll, which is liable to result from heat, particularly if prolonged, may be modified if the water is alkaline. It has been observed that fresh peas cooked in a large amount of alkaline water may be cooked slowly in a covered utensil and still retain their bright green color. One authority advises the use of a large amount of water, i.e. three cups of water to two cups of peas, the addition of one-sixteenth of a teaspoonful of soda, and a twenty to thirty minute boiling period (33). The addition of sodium bicarbonate in pea cookery is not advised, because:

(1) antineuritic and antiscorbutic vitamins are reduced in an alkaline medium; and, (2) correct varietal selection and proper cooking procedure insures a colorful, palatable product (47).

Hydrogen-ion concentration of water. Studies made on the influence of all types of water in the various processes of canning showed that the calcium and magnesium compounds of hard water had the property of hardening certain vegetables, especially peas. The effect of hard water proved to be negligible in the brief period required for the washing and rinsing processes. It was found, however, that the first peas that passed through the continuous blancher removed the chemical compounds of magnesium and calcium and so softened the water for the succeeding peas. From the results obtained, it is considered advisable to soften the water used in blanching when the hardness of the water exceeds 200 parts per million. Water used in the brine for packing and the amount of the calcium in the salt may also have a pronounced influence on the hardness of the peas (9). In this study, the use of distilled and tap water (average pH 7.1) in cooking frozen peas gave no differences in the cooked product. This result may have been due to the fact that the hydrogen-ion content of the Corvallis tap water was practically neutral.

From the experiments reported, directions for cooking frozen-pack peas, and a household recipe were formulated.

Directions for cooking frozen peas. Place 340 grams of undefrosted frozen-pack peas in a 2 liter saucepan. Add 2.5 grams of salt and 177 cubic centimeters of boiling water. Place uncovered saucepan on an open heating unit which has been previously heated. Note the time when the water begins to boil in any part of the pan, and boil for three or four minutes beyond that time.

Household recipe. Remove one pint of frozen-pack peas from their container and place them in a two quart saucepan without defrosting. Add one-half teaspoonful of salt and three-fourths cup of boiling water. Place the uncovered saucepan on an open heating unit previously heated and note the time as soon as the water begins to boil in any part of the pan. Boil the peas three or four minutes, reducing the heat as soon as the water has reached a rolling boil (52).

Peas may be seasoned in various ways. Some suggestions with quantity of seasonings are listed below.

Quantity of Seasonings

Buttered Peas

Butter - 1 1/3 T.
Salt - a few grains
Pepper - a few grains

Quantity of Seasonings

Creamed Peas

Cream - 1/4 c.
Salt - a few grains
Pepper - a few grains

Peas with Bacon

Bacon - 1 1/2 strips, diced, cooked
Onion - 1/3 small, grated into cooking water
Salt - a few grains
Pepper - a few grains

Peas with Mint

A sprig of mint or mint leaves may be boiled with the peas when preparing buttered or creamed peas.

CARE OF FROZEN-PACK PEAS AFTER PURCHASING

The homemaker in the Pacific Northwest probably uses one or more of the following devices for keeping her daily supply of food: a cooler, an ice-cooled refrigerator or a mechanical refrigerator. In considering the problem of adequate storage for frozen-pack peas in the home after purchasing, it seemed desirable to examine the condition of the peas kept in coolers, in refrigerators using ice, and in mechanical refrigerators for different periods of time.

Preliminary tests. Storing frozen-pack peas in an ice-cube compartment of a mechanical refrigerator (16° F. ave.) for two weeks, in an ice-cooled refrigerator (43° F. ave.) for 2 3/4 days, and in a cooler (65° F. ave.) for 2 3/4 days, when the average maximum and minimum outdoor temperature was 72° F. and 55° F., respectively, resulted in slight drying of the surface layer of peas held in the mechanical refrigerator, in defrosting the peas kept in the ice-cooled refrigerator, and in definite spoilage of the peas placed in the cooler. In the last case, deterioration was shown

by the absence of green color, and by the sour odor due to the presence of lactobacilli organisms.

The results of a brief study of the temperatures of coolers, made during the latter part of February, are given in table 9. While the coolers in individual houses appeared to have colder sections than those in apartments, they did not show an average temperature below 50° F., which is considered maximum for the storage of any perishable food for as short a period of time as twenty-four hours (23).

Table 9

Average Temperatures of Coolers from February 22 through March 6, 1936 in Tacoma, Washington

Outdoor temperature		Average Temperatures in coolers				Type of residence
		Lowest shelf		Top shelf		
Max.ave.	Min.ave.	A.M.	P.M.	A.M.	P.M.	
54° - 43° F.		50° - 51° F.		62° - 67°F.		House
54° - 43° F.		51° - 52° F.		56° - 61°F.		House
54° - 43° F.		60° - 65° F.		62° - 64°F.		Apt.
54° - 43° F.		61° - 64° F.		64° - 66°F.		Apt.

Defrosting Tests

Studies were made to find out how long the peas would remain frozen when kept under different conditions.

A preliminary test showed that defrosting occurred in less than twenty-four and forty-eight hours, in ice-cooled and mechanical refrigerators, respectively. During the test it was decided to see how much longer than fifteen and thirty-six hours defrosting would require in ice-cooled and mechanical refrigerators. In each case the cartons were left unopened until the proposed period for defrosting had terminated. At the expiration of the time decided upon, the contents of one carton were examined. If the peas had not defrosted, the test was continued. Defrosting was considered complete when practically all of the ice crystals had disappeared. The time required to defrost the peas is listed in table 10.

Since the temperatures of refrigerators are supposed to become stabilized overnight, the thermometers were read each morning at eight-thirty. In as much as the results obtained (table 10) show that it required twenty-two more hours for the peas placed on the lowest shelf of the mechanical refrigerator to defrost,than it took for the peas placed on the top shelf of the same refrigerator, the desirability of storing a sealed carton of frozen food in the coldest part of the refrigerator is obvious.

Table 10

Time Required to Defrost Peas

at Different Temperatures

Average room temperature	Place defrosted	Average temperature of defrosting device	Average hours required to defrost	Number of tests made
71.6° F. 22° C.	Room	71.6° F. 22° C.	6 1/2	4
73.4° F. 23° C.	Refrigerator-ice-cooled	50° F. 10° C.	18	4
75.3° F. 24° C.	Refrigerator-mechanical (top shelf)	47.3° F. 8.5° C.	20	4
75.3° F. 24° C.	Refrigerator-mechanical (bottom shelf)	38.3° F. 3.5° C.	42	4

Bacteriological tests. Another set of defrosting experiments were initiated to determine the bacteriological changes in peas kept at various temperatures. Frozen-pack peas were defrosted at room temperature, in an ice-cooled refrigerator, and in two locations in a mechanical refrigerator. At two day intervals the unopened cartons were taken to the bacteriology department for examination. The results obtained on the various packages are given in table 11.

Table 11

Bacteria per Gram in Peas Defrosted

at Different Temperatures

Ave. Room Temp. F.	Ave. Room Temp. C.	Lot Number	Place	Ave. Temp. of Defrosting Device F.	Ave. Temp. of Defrosting Device C.	Time (Days)	Bacteria per Gram
		5_1	Mech. Re. (lowest				6,000
67°	19.44°	5_2	shelf)	32.9°	0.5°	4	3,000
		5_{13}	Mech. Re. (lowest				5,000
68°	20°	5_{14}	shelf)	35.6°	2°	4	3,000
		5_{15}	Mech. Re. (top				10,000
65°	18.33°	5_{16}	shelf)	48.2°	9°	2	9,000
		5_3	Mech. Re. (top				8,000
67°	19.44°	5_4	shelf)	50°	10°	4	7,000
		5_{11}	Mech. Re. (top				9,000
68°	20°	5_{12}	shelf)	48.2°	9°	4	8,000
		5_{17}	Ice-cooled				15,000
58°	14.44°	5_{18}	Re.	44.6°	7°	2	10,000
		5_5	Ice-cooled				78,000
63°	17.22°	5_6	Re.	46.4°	8°	4	107,000
		5_{19}					1,000,000
65°	18.33°	5_{20}	Room	65°	18.3°	2	1,400,000
		5_7					4,300,000
68°	20°	5_8	Room	68°	20°	4	4,500,000

Discussion. The limitations in these defrosting experiments were numerous. Throughout the observations, commercial pack peas of an excellent grade were used, but the conditions under which the peas were grown and harvested were unknown. The defrosting was done in a room which was not heated at night or over the weekend. While the thermometer readings were recorded in the morning when the refrigerator temperatures were supposed to have become fixed during the night, the maximum room temperature had not been reached. The temperature in the ice-cooled refrigerator (used solely for the experiment) remained about the same while the temperature on the top shelf of the mechanical refrigerator was unusually high (58° F.) for two successive days. The sudden high temperature might have been due to impaired circulation from overcrowding the storage space with food supplies or to the fact that the refrigerator doors were frequently opened on account of laboratory lessons.

The analyses were of value in that they showed rapid spoilage of peas held at room temperature and the unsuitability of the ice-cooled refrigerator for more than a few hours storage of frozen foods, even if the defrosting of frozen peas was not done in a special room of constant heat. Although the average temperatures in the refrigerator using ice and in the warmest

part of the mechanical refrigerator, were practically the same, the bacterial count per gram differed considerably. This difference in numbers of microorganisms present might have been due to the fact that the temperature in the mechanical refrigerator became lower overnight.

From the bacteriological examination, it would appear that peas may be kept on the coldest shelf on the mechanical refrigerator for four days (table 11) when necessary. Since peas kept on the coldest shelf of the refrigerator defrosted in less than two days (table 10) and there is no advantage to be gained in defrosting, the practice of allowing peas to thaw before cooking is to be discouraged. It is believed to be the best procedure to keep the peas frozen solid until ready to cook them. This approved method requires a slightly longer time to bring the product to the boiling point in cooking, but the guarantee of freedom from an increase of bacteria makes such a precautionary measure wise.

COMPARISON OF FRESH, CANNED, AND FROZEN-PACK PEAS IN QUALITY

Since frozen-pack peas are increasingly replacing canned peas in menus, it seemed advisable to compare the quality of frozen-pack peas with the fresh and canned from the standpoint of the home consumer. The fresh Telephone peas used in July were grown in Astoria, Oregon. During December the same variety of peas from California were shipped in from the Portland market. The data for fresh peas is given in tabular form.

Description of Fresh Peas

Date 1936	No. of tests	Cost per lb. (cents)	Ave.Wt. peas (grams)	Ave.Wt. shelled peas (grams)	Ave.Vol. in (cups)	% of waste
July	4	*3/.20	714	294	2 3/16	58.5
Dec.	3	2/.25	878	326	2 1/3	63.7

Legend: * indicates 3# cost 20¢.

Fresh peas. In comparing the cooking of the frozen-pack peas with fresh peas, the boiling period of four minutes was kept the same, except in two experiments when the time of boiling was doubled for the fresh peas. An additional fifty seconds was allowed in cooking the

fresh peas, to equal the time of the scalding period employed in preparing the peas before freezing. The average total time of cooking was less for the fresh than for the frozen peas because the water in which the fresh peas were cooked began to boil on an average of two minutes and twenty-five seconds, while the water in which the frozen peas were cooked began to boil on an average of six minutes and two seconds.

Results. The fresh and frozen peas were judged according to the score card used in the other cooking tests.

Table 12

Average Scores for Frozen-pack and Fresh Peas

Date 1936	Peas	Average total cooking time (min.)	Average score	Peas	Average total cooking time (min.)	Average score
7/29	Fresh	7' 31"	89	Frozen	9' 34"	94
7/30	Fresh	7' 5"	81	Frozen	10' 18"	96
12/9	Fresh	7' 21"	92	Frozen	9' 51"	89
12/10	Fresh	12' 8"	85	Frozen	10' 5"	92
12/11	Fresh	12' 34"	71	Frozen	10' 40"	90
Average score			83.6			92.2

Since fresh peas were rated too mature, it would seem that the marketing methods employed in respect to fresh peas might be altered so as to supply consumers with a

less mature product. The necessity of not picking the entire pea crop at one time and of providing cooling facilities before and during shipping was brought to the attention of New York farmers through a study made to determine why green peas shipped from the state of Washington brought a better price in New York City than those grown in its immediate vicinity (37).

Conclusion. The fact that the average score for the fresh peas, as given in table 12, was less than that for the frozen peas indicates that the latter were preferred to the fresh peas purchased in either July or December. At the end of the cooking period, the fresh peas were not tender enough in texture, but it has been observed that an increase in the length of time in cooking does not produce a desirable product when peas are overmature.

Canned peas. The best grade of peas obtainable in a fancy pack were used in comparing heated canned peas with the cooked frozen-pack peas. In order to make the conditions comparable and not overcook the canned peas, the liquor drained from a #2 can of peas was brought to the boiling point and poured over the peas. The peas were then heated to a rolling boil, removed from the fire, and poured into a vegetable dish for scoring. The results of this comparison are recorded in table 13.

Table 13

Average Scores for Frozen-pack and Canned Peas

Peas (kind)	Number of tests	Average total cooking time (min.)	Color	Average score
Canned	4	5' 33"	Y 6/8	56
Frozen	5	10' 7"	GY-G 5/8	92

Conclusion. Although the quality grade of the canned peas was the highest, the product appeared to be inferior to cooked frozen-pack peas in every respect. No points of similarity were observed between the two products.

ECONOMY OF THE USE OF FROZEN-PACK PEAS

Some individuals (approaching mature adulthood) remember when their winter's supply of vegetables, viz: cabbage, carrots, beets, parsnips, and potatoes, was packed in straw and buried below frost level. At that time variety was introduced into the spring menu by nature's lavish production of greens, such as dandelion, sorrel, or lamb's quarter. Today, even the smaller towns (table 14) may have as high as twenty fresh vegetables available in the market during any month of the year, due to modern methods of shipping produce under refrigeration to the large terminal markets for distribution.

An attempt was made in this limited survey to discover the availability of frozen-pack peas for the homemaker in various sections of the United States, to make a comparison of the cost of frozen-pack peas with fresh and canned peas, and to secure prices of fresh vegetables in different cities from November through April.

To ascertain the kinds of fresh vegetables available in city markets, questionnaires, a copy of which follows, were sent to a number of individuals during the fall of 1934. In January, copies of the same questionnaire were sent to the various state colleges to learn

Questionnaire Used to Obtain Data

About Fresh Vegetables

Date Place

Name of Fresh Vegetables Available	(In Season)		Shipped in (Out of Season)	
	Market Unit	Cost Per Unit	Market Unit	Cost Per Unit
Asparagus				
Beans, string				
Beets				
Cabbage				
Carrots				
Cauliflower				
Celery				
Cucumbers				
Eggplant				
Leeks				
Lettuce				
Okra				
Onions, green				
Onions				
Parsnips				
Peas, in pod				
Potatoes				
Radishes				
Rutabagas				
Spinach				
Squash, Hubbard				
Tomatoes				
Turnips				

what fresh vegetables were obtainable during the second week of February. Unreasonable shopping was not intended as the answers were to be obtained at their regular trading places.

From the questionnaires returned from thirty-seven states, fifteen cities were chosen for analysis of replies. The price lists for some of the vegetables obtainable in these cities is given in table 14. Average 1934-35 prices of fresh peas were obtained from the 160 questionnaires returned (table 15). In computing averages, the price of fifteen cents a pound was used when peas were listed two pounds for twenty-five cents.

Cost per serving. From the prices listed, it may be readily seen that many individual portions of vegetables could be obtained for less than six cents for a serving of one-half cup. (Each serving of frozen-pack peas cost six cents since there were four one-half cup servings in a twelve ounce package. Each package sold for twenty-three cents.) However, there were also other vegetables such as artichokes, hothouse asparagus shipped from Illinois to California, cauliflower, eggplant, green peppers, tomatoes and fresh peas that cost from six to nineteen cents per serving.

It was learned from the 236 self-addressed post cards (a copy of which is given on page 82) sent to individuals in 1935: (1) that small towns did not have fresh peas in market from November through April, unless they were a suburb of a large city (table 16, appendix); (2) that the average prices of fresh peas per

Questionnaire Used to Obtain Data

About Peas

City

Date

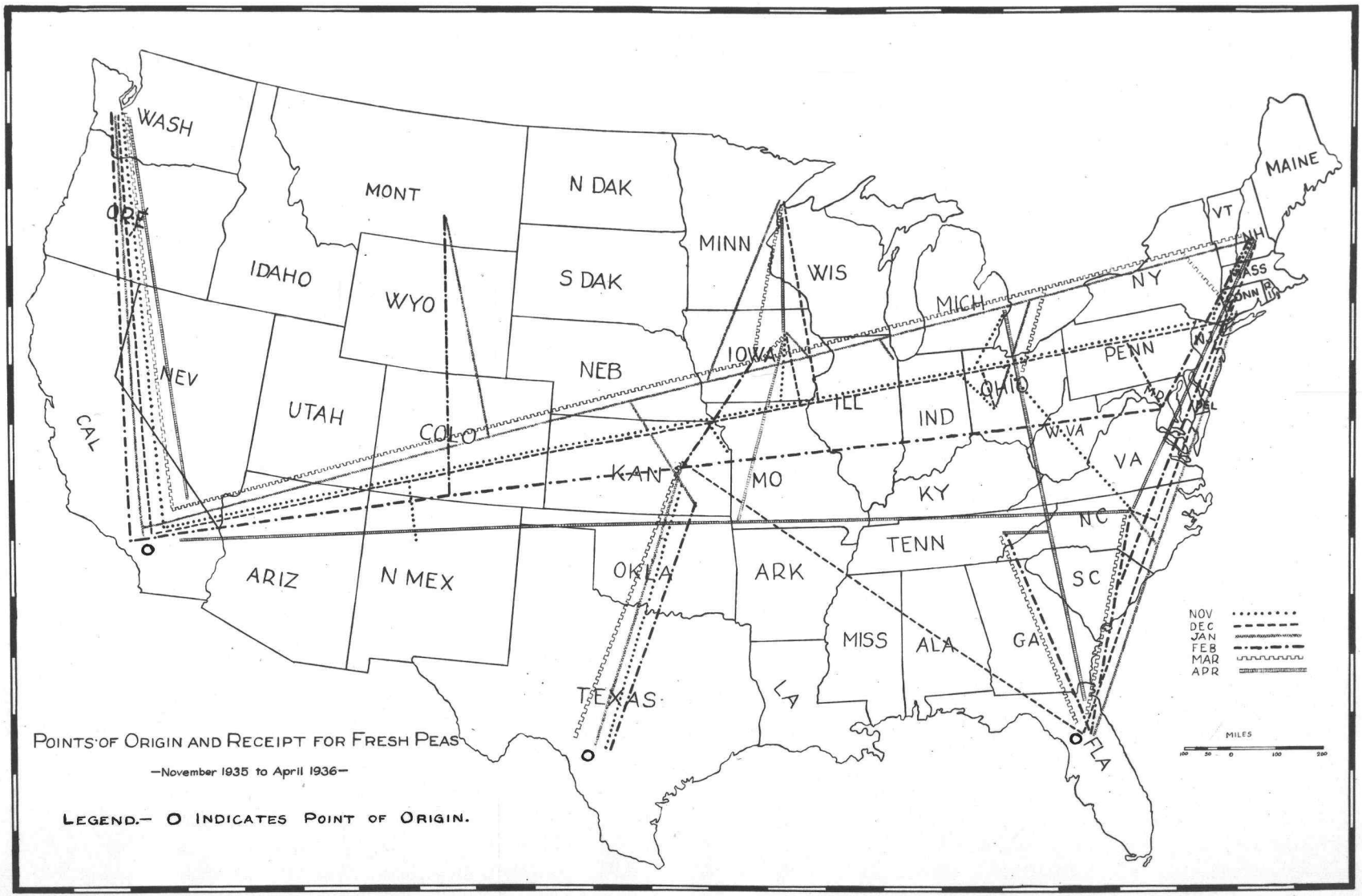
State

(during second week)

Product	Retail Market unit	Grade	Retail cost of unit	Grown in state of	Check if none
Peas, green		X			
Peas, canned	#2 can #2 can #2 can	Fancy Choice Standard		X	X
Peas, frozen-pack				X	

X Omit

pound ranged from thirteen cents in February to sixteen cents in December (table 16, appendix); (3) that the average prices of #2 fancy pack canned peas ranged from seventeen to twenty-five cents (table 17, appendix); (4) that the retail cost of frozen-pack peas (a) in Concord, New Hampshire was twenty-five cents for a twelve ounce package, (b) in Duluth, Minnesota was thirty-five cents for a twenty-four ounce package; (c) in Seattle, Washington was thirty cents for a twenty ounce package, (d) in Portland, Oregon was twenty-three cents for a twelve ounce package, (5) and that California, Texas and Florida supplied the nation with fresh peas during the winter months. Points of origin to receipt of fresh peas are shown on map 1.



POINTS OF ORIGIN AND RECEIPT FOR FRESH PEAS

—November 1935 to April 1936—

LEGEND.— O INDICATES POINT OF ORIGIN.

Table 18

Average Prices of Fresh Peas

November, 1934 through April, 1936

Year	Number of Cities*	Nov.	Dec.	Jan.	Feb.	Mch.	Apr.	Total Average
1934-5	14	$.15	$.18	$.18	$.13	$.13	$.13	$.15
1935-6	20	$.15	$.16	$.15	$.13	$.16	$.15	$.15

* Replies (monthly) not received from all cities.

Conclusion. Allowing five servings to a #2 can of peas, one serving of canned peas from the prices listed would cost from three to five cents; a serving of commercial frozen-pack peas would cost six cents; and a half cup serving of fresh peas from November through April would cost eight cents (12). Thus the cost of the frozen peas falls between that of canned and fresh peas. According to Joslyn, the main justification for freezing peas lies in the better preservation of color and flavor (39).

Home Freezing of Peas

If frozen-pack vegetables are to replace canned vegetables, it is necessary for the housewife to find a household method for this form of preservation. In the

equable climate of the Pacific Northwest many garden plots are accessible to the person who desires to preserve her own foodstuffs. Green peas, preserved by freezing within six hours of harvesting, are a delicacy within the reach of anyone who has access to a cold storage locker. This has been possible since the individual storage lockers have become obtainable at many creameries, canneries, and refrigeration plants.

Attempts to freeze vegetables in the same way as meats and berries are frozen resulted in "off or hay-like flavors" after six to eight weeks of storage at temperatures available (41). Such failures need not have occurred if the vegetables had been properly scalded to check respiration and all enzymatic activity before freezing.

Varieties. Just as certain kinds of berries are adapted to freezing, only particular varieties of peas are desirable for freezing (table 19) from the standpoint of yield, growth, brilliant green color upon scalding, and absence of "grassy" flavor after scalding.

Table 19

Varieties of Peas Recommended for Frozen-pack in New York, Virginia, and Washington-1936

Variety of peas	State	Authority
World's Record	Washington	Diehl
President Wilson	Washington	Diehl
Alderman	Washington	Diehl
Thomas Laxton	New York	Tressler
President Wilson	New York	Tressler
Alderman	New York	Tressler
Thomas Laxton	Virginia	Moon, et al
Asgrow 40	Virginia	Moon, et al

Directions for home freezing. According to Wiegand's suggestions, "the peas were picked at the tender, succulent stage when best suited for table use" (85). After shelling, the peas were washed in cold tap water to allow the "blisters" to float off. A pint of peas was then poured into a strainer that had an extension frame which rested on the opposite edges of the five gallon preserving kettle while the peas were plunged into boiling water for sixty seconds. In using such a small quantity of peas, the workers were probably unduly cautious in their aim not to allow the temperature of the water to fall below 200° F. during the scalding period. The foaming which occurred during the scalding period is believed to be caused by lowered surface tension,

tension, due to soluble nitrogenous substances, tannins and saponins (47). It has not been determined how often the water might need to be changed on account of this factor, but it probably would not concern the homemaker when small quantities are frozen. After scalding, the peas were poured into a large enamel pan, which had been filled with cold tap water to effect rapid cooling. As soon as the peas had become cooled, they were packed in glass topped jars to within one-fourth of an inch of the top of the container to allow for expansion. The lid was left loose until after the contents had frozen (85). The filled jar was kept in a mechanical refrigerator until the remaining peas had been prepared. Within three hours of picking, the jars of dry-pack peas were so distributed on a shelf in a storage locker that cold air surrounded each individual jar to accelerate the freezing process. The second clamp was adjusted the following day, when the jars were packed in cartons for more compact storage.

Two varieties of peas with edible pods were frozen as a preliminary test. As no record of previous tests were obtainable, a two minute scalding period was used for the flat edible podded Swedish peas, and a three minute scalding period was used for the Dreer's fleshy Sugar-stick peas. Upon examination, at the expiration

of six months, the attractive green color was retained perfectly, both after freezing and after cooking. When the product was cooked, the peas with edible pods had very good color, texture, flavor, and appearance. The pods were intact when placed in the boiling water, but usually separated into two halves upon cooking.

Data for Home-frozen Garden Peas

Lot. No.	Variety	Scalding time	Temperature of water	Pack	Type of container	Size
7_1	Thomas Laxton	60 sec.	Above 200° F.	Dry	Glass jar	Pint
7_2	Unnamed	60 sec.	Above 200° F.	Dry	Glass jar	Pint
7_3	Dreer's Sugar-sticks	180 sec.	Above 200° F.	Dry	Glass jar	Pint
7_4	Swedish edible-podded	120 sec.	Above 200° F.	Dry	Glass jar	Pint

Comparison of the Quality of Home-frozen Pack and Commercial Frozen-pack Peas

In removing home-frozen peas from the jar, hot tap water was allowed to run over its exterior, before the three-fourths cup of boiling water was carefully poured onto the peas in the jar. On account of the immaturity of the home-frozen peas, the boiling time was reduced to

three and a half minutes, while that of the commercially frozen peas remained at the usual period of four minutes. The home product was frozen according to directions given for home-frozen peas. Both fresh and frozen peas were judged according to the score card used previously in the study.

The average scores for home-frozen peas compared with commercially frozen peas are given in table 20.

Table 20

Average Scores for Frozen-pack Peas

Packed under Different Conditions

Frozen-pack peas	Number of tests	Average total cooking time	Average score
Commercial	3	10' 12"	92
Home Lot 1	3	8' 52"	85
Home Lot 2	1	8' 2"	58

Results. The first experimental pack of cooked home-frozen peas did not score as well as the commercial one on account of their immaturity. In appearance, they were concave on one side due to undeveloped cotyledons; their texture was soft, their flavor unusually sweet and their color very good. Lot 2 of the experimental home-frozen peas were particularly suited for canning,

in that they were light colored and small at maturity (75). The color of these peas which were cooked in a preliminary test for comparing fresh and frozen peas was recorded as green-yellow (GY 7/6) instead of green-yellow-green (GY-G 6/8), the usual designation recorded for attractive cooked fresh and frozen peas. The flavor of the cooked fresh peas was rated only moderately desirable, in that they seemed to be less sweet than good varieties of sweet garden peas. These two major faults, lack of green color and excellency of flavor, precluded the possibility of producing even a fair frozen-pack product from this variety.

Conclusion. From the results obtained in comparing home-frozen and commercially frozen peas, it was concluded: (1) that peas with correct varietal characteristics (Thomas Laxton was used in this instance) may be successfully and economically frozen by the homemaker, and (2) that it is not advisable to freeze peas lacking green color in the epidermis and the characteristic sweet flavor of fresh garden peas, because freezing only conserves the good qualities inherent in the product itself.

SUMMARY AND CONCLUSIONS

1. A study of the use of frozen-pack peas by the home consumer has been made.

2. A standard method of cooking frozen-pack peas was developed from which a household recipe for cooking was formulated.

3. The quality of the cooked product was not effected to any significant degree by the depth or width of the saucepan, by varying the amount of water, or by using saucepans of different materials. Three or four minute periods of boiling produced optimal results in cooking frozen peas. The flavor of the peas was improved by adding the salt before, rather than after the peas were cooked. No differences were noted in color, flavor, and texture when tap water (average pH 7.1) was used in place of distilled water; nor were differences noted when frozen and defrosted peas w ere used.

4. In determining possible storage facilities for frozen peas in the home, coolers with a temperature range from 50° to 67° F. were found to be unsatisfactory. The coldest shelf of a mechanical refrigerator provided the best means for temporary storage in the home.

5. In quality frozen-pack peas were preferable to fresh peas usually purchased on the market. Frozen peas were unanimously rated higher than canned peas.

6. The average cost of one serving (one-half cup) of frozen peas was six cents; the average cost of the same size serving of canned peas of high quality grade was four cents; the average cost of the same measure of fresh peas from November 1935 to April 1936 was eight cents.

7. For more accurate determinations of storage temperatures in the home a recording thermometer and a Brown potentiometer are recommended. Furthermore, a special color analyzer would be desirable to distinguish differences in color more accurately.

8. The comparative losses in nutritive value in frozen-pack, canned, and fresh peas which occur during the various methods of handling and of cooking, need to be studied.

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APPENDIX

Record Card for Cooked Frozen-pack Peas

Sample No. _____ Date _____

Judged by ____

Qualities	5	4	3	2	1
Appearance	Plump (well filled out)	Slightly wrinkled*	Concave on one side	Somewhat collapsed	Collapsed
Color	GY-G	GY-G *	GY-G	GY	GY
Texture	Firm yet tender	Less firm but sufficiently tender*	Soft	Somewhat mushy	Mealy
Flavor	Desirable	Moderately desirable *	Slightly desirable	Neutral	Slightly undesirable
Conclusions	Excellent	Very good	Good	Fair	Poor
	100%	90%	80%	70%	60%

Comments:

To obtain numerical score, allow 10 for general appearance, 20 for color, 30 for texture, and 40 for flavor.

	Sample 1/32	Sample 1/31 *
Appearance	9 (90% of 10)	9 (90% of 10)
Color	18 (90% of 20)	18 (90% of 20)
Texture	24 (80% of 30)	27 (90% of 30)
Flavor	28 (70% of 40)	36 (90% of 40)
Total	79	90

Table 14

Prices of Fresh Vegetables Available in
Fifteen Cities, February, 1935

Name		Artichokes	Asparagus	Beans	Beets
Market Unit		per Choke	Bunch	String 1b.	Bunch
Servings in 1#		2	4(½c)	7(½c)	3(½c)
	Population				
Arkansas					
Fayetteville	9,700	*	*	*	1/.10
California					
Berkeley	85,000	4/.10	1b/.50	*	2/.05
Colorado					
Ft. Collins	12,000	*	*	*	1/.05
Delaware					
Newark	4,500	*	*	1/.15	1/.10
Florida		Cuba	S.Car.		
Gainesville	12,000	1/.20	1/.25	1/.25	1/.10
Georgia					
Atlanta	270,366	*	*	1/.10	1/.10
Idaho					
Moscow	4,415	1/.10	2/.15	1/.10	2/.15
Illinois				Ariz.	A riz.
Franklin Park	2,423	1/.19	1/.25	2/.15	1/.08
Indiana			Ohio		
La Fayette	25,000	1/.17	1/.30	1/.15	1/.05
Massachusetts					
Amherst	5,888	*	*	qt/.20	1/.12
Minnesota					
Minneapolis	464,356	*	*	1/.30	1/.10
Missouri					
Columbia	14,967	*	1/.20	1/.19	2/.05
New Hampshire					
Concord	25,000	1/.10	*	*	1/.10
Oklahoma					
Oklahoma City	186,311	*	*	1/.10	1/.07
Washington					
Tacoma	110,000	2/.15	*	*	4/.10

Legend: _____, _ _ _, _ _, _ indicates shipped in from Cal., Fla., Tex., and Ga., respectively.
* None in market.
Local not underscored.
= Source not indicated.

Table 14

Prices of Fresh Vegetables Available in

Fifteen Cities, February, 1935

Name	Broccoli	Brussels	Cabbage	Carrots	Cauliflower
Market Unit	Pound	Sprouts lb.	Head	Bunch	Pound
Servings in 1#	6(½c)	4(3/4c)	5(½c)	4(½c)	4(3/4c)
Arkansas					
Fayetteville	1/.15	1/.25	1b/.06	1/.10	1/.15
California					
Berkeley	1/.05	1/.10	2/.15	2/.05	1/.10
Colorado				Ariz.	
Ft. Collins	*	1/.20	1b/.04 3	1/.05	2/.25
Delaware					
Newark	*	*	1b/.25	2/.15	1/.22
Florida					
Gainesville	1/.15	1/.20	1/.08	1/.10	1/.10
Georgia					
Atlanta	*	*	1b/.03	1/.07	1/.15
Idaho					
Moscow	*	2/.25	1b/.04	2/.15	1/.10
Illinois	Bunch				Head
Franklin Park	1/.15	*	1b/.08	1/.06	1/.12
Indiana					
La Fayette	1/.18	1/.18	1b/.05	1/.06	1/.18
Massachusetts	Bunch		New		Head
Amherst	1/.25	qt/.29	1b/.06	1/.10	1/.29
Minnesota			New		Head
Minneapolis	*	qt/.25	1b/.05	1/.08	1/.25
Missouri					Head
Columbia	*	1/.25	1b/.05	1/.05	1/.21
New Hampshire			New		
Concord	1/.15	1/.25	1b/.06	1/.08	1/.13
Oklahoma			New		
Oklahoma City	*	pt/.15	1b/.06	1/.05	1/.13
Washington					Head
Tacoma	2/.15	1/.10	1b/.03	4/.10	1/.15

Legend: _____, _ _ _, _ _, _, indicates shipped in from Cal., Fla., Tex., and Ga., respectively.

* None in market.

Local not underscored.

= Source not indicated.

Table 14

Prices of Fresh Vegetables Available in

Fifteen Cities, February, 1935

Name	Celery	Cucumbers	Eggplant	Lettuce	Onions
Market Unit	Bunch	Each	Each	Head	Bunch
Servings in 1#	4(½c)	5	6(½c)	6	4
Arkansas				Ariz.	
Fayetteville	1/.15	1/.15	*	1/.10	*
California					
Berkeley	1/.15	1/.15	1b/.15	1/.05	3/.10
Colorado					
Ft. Collins	1/.15	1/.13	*	2/.15	3/.10
Delaware					Bermuda
Newark	3/.19	1/.15	*	2/.15	1/.05
Florida					
Gainesville	1/.10	1/.05	2/.25	1/.10	1/.10
Georgia					
Atlanta	1/.09	1/.10	1b/.15	1/.09	1/.05
Idaho					
Moscow	1/.17	1/.25	1/.10	2/.25	1/.05
Illinois					
Franklin Park	3/.17	1/.17	1/.08	1/.05	1/.07
Indiana			Cuba		
La Fayette	1/.15	1/.15	1/.16	1/.07	
Massachusetts			South		
Amherst	1/.18	1/.20	1b/.45	1/.10	*
Minnesota		Mexico			
Minneapolis	1/.12	1/.25	*	1/.10	1/.10
Missouri					
Columbia	2/.25	2/.25	*	1/.10	*
New Hampshire		Ind.	Cuba	Ariz.	
Concord	1/.18	1/.20	1/.18	1/.15	*
Oklahoma					
Oklahoma City	1/.15	1/.20	*	1/.07	2/.15
Washington					
Tacoma	1/.10	1/.10	*	2/.15	1/.05

Legend: _____, _ _ _, _ _, _, indicates shipped in from Cal., Fla., Tex., and Ga., respectively.

* None in market.

Local not underscored.

Table 14

Prices of Fresh Vegetables Available in

Fifteen Cities, February, 1935

Name	Peas	Peppers	Radishes	Spinach	Tomatoes
Market Unit	Green lb.	Green lb.	Bunch	Pound	Pound
Servings in 1#	2(½c)	6	3	5(½c)	3(½c)
Arkansas					
Fayetteville	*	1/.20	1/.05	*	1/.22 Mexico
California					
Berkeley	3/.25	1/.20	2/.05	1/.05	1/.20
Colorado					
Ft. Collins	2/.25	*	3/.10	2/.15	1/.20
Delaware					
Newark	2/.25	*	1/.05	2/.25	1/.19
Florida		Each			Cuba
Gainesville	2/.25	2/.05	1/.10	1/.15	1/.15
Georgia					Cuba
Atlanta	1/.10	*	1/.05	2/.25	1/.18
Idaho					
Moscow	1/.15	*	1/.05	1/.10	1/.25
Illinois		Each			
Franklin Park	1/.13	3/.10	3/.10	1/.13	1/.15
Indiana	Mexico				Mexico
La Fayette	1/.15	1/.10	1/.07	1/.15	1/.16
Massachusetts					
Amherst	1/.19	1/.25	1/.08	pk/.45	1/.25
Minnesota					Mexico
Minneapolis	1/.15	1/.30	1/.05	1/.15	1/.20
Missouri		Each			
Columbia	*	1/.10	1/.05	*	1/.19
New Hampshire					
Concord	1/.18	1/.25	1/.05	pk/.39	1/.18
Oklahoma					Mexico
Oklahoma City	*	*	1/.05	*	1/.20
Washington		Mexico			Mexico
Tacoma	1/.15	1/.30	4/.10	2/.15	1/.15

Legend: _____, _ _ _, _ _, _, indicates shipped in from Cal., Fla., Tex., and Ga., respectively.
* None in market.
Local not underscored.
= Source not indicated.

Table 15

Price per Pound of Fresh Peas

Nov. 1934--April 1935

	Population	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Alabama							
Florence	10,529	*	*	1/.10	2/.25	*	1/.15
California				* * *	* * *		* * *
Pasadena	85,000	1/.10	2/.13	1/.10	1/.10	2/.15	1/.10
Florida							
Lakeland	32,000	*	*	2/.25	2/.25	2/.25	2/.25
Georgia							
Atlanta	270,000	1/.12	1/.15	2/.25	1/.10	*	1/.15
Hawaii				* * *	* * *		* * *
Hilo	20,000	*	1/.30	1/.15	1/.15	*	1/.15
Kansas							
Lawrence	15,000	1/.15	1/.17	1/.20	1/.15	1/.15	1/.15
Michigan		* * *	* * *	* * *	* * *	* * *	* * *
Detroit	1,564,000	1/.15	1/.30	1/.22	1/.13	1/.15	1/.16
Minnesota		La.	* * *	* * *	* * *	* * *	* * *
Duluth	90,000	1/.19	1/.20	1/.35	1/.20	2/.25	1/.15
Ohio		* * *	* * *	* * *	* * *	* * *	* * *
Martins Ferry	16,000	2/.35	1/.20	1/.20	1/.15	2/.25	*
Oregon		* * *	* * *	* * *	* * *	* * *	
Salem	26,000	2/.25	*	*	1/.10	3/.25	2/.15
Tennessee					Shelled		
Knoxville	120,000	*	1/.15	1/.20	1/.20	1/.20	3/.25
Utah			* * *	* * *	* * *	* * *	* * *
Salt Lake City	160,000	*	1/.10	*	1/.13	1/.12	1/.08
Washington			* * *		* * *	* * *	
Spokane	135,000	1/.18	*	2/.45	*	*	2/.25
		* * *		* * *		Mex.	* * *
Tacoma	110,000	1/.15	1/.15	1/.15	1/.15	2/.25	2/.23
		* * *					
Washington,D.C.	600,000	*	2/.29	2/.25	3/.25	3/.25	3/.19
			* * *	* * *	* * *	* * *	* * *

Legend: ____, _ _ _, _ _, _, indicates shipped in from Cal., Fla., Tex., and Ga., respectively.
* None in market.
Local not underscored.
* * * Shipped in. Source not indicated.
Average cost per lb. 15¢.

Table 16

Price per Pound of Fresh Peas

Nov. 1935--April 1936

	Population	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
California							
Calexico	6,299	2/.25	2/.25	2/.15	3/.25		
Sebastopol		2/.23	1/.13	2/.25	2/.27	2/.15	3/.19
Connecticut							
Bridgeport	146,716	1/.15	2/.25	1/.15	2/.25	1/.10	2/.35
Florida							
Miami	110,637	2/.19	2/.19	2/.19	2/.19	2/.19	2/.19
Illinois							
Chicago	3,376,438	1/.19	2/.29	2/.33			
Peoria	104,969	1/.17	1/.17	1/.17			
Indiana							
Peru	12,730	1/.15	1/.20				
Iowa							
Cedar Falls	7,362	1/.15	1/.15	1/.15	2/.25	1/.15	1/.10
Kansas							
Independence	12,782			1/.15	2/.15	*	2/.25
Manhattan	10,136		2/.35	2/.25		2/.25	* * *
Maryland							
Takoma Park	6,315	2/.25	2/.25		3/.19	2/.29	2/.25
Michigan							
St.Clair Shores	6,745	1/.15	*	*	*	*	1/.17
Minnesota							
Duluth	101,463	*	1/.20	2/.25	2/.25	2/.25	1/.15
Missouri							
Kansas City	399,746	2/.39	2/.19	3/.25	2/.29		
			* * *	* * *	* * *		
Montana							
Billings	16,380	*	*	1/.20	2/.35	*	2/.25

Legend: _____, _ _ _, _ _, _, indicates shipped in from Cal., Fla., Tex., and Ga., respectively.
* None in market.
Local not underscored.
* * * Shipped in. Source not indicated.

Table 16

Price per Pound of Fresh Peas

Nov. 1935--April 1936

	Population	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Manitoba							
Winnipeg	218,785	*	*	1/.15	1/.16	1/.16	1/.19
New York				* * *	* * *	* * *	* * *
New York City	6,930,446	*	1/.16	2/.27	1/.10		
North Carolina							
Durham	52,037	1/.15	2/.25	1/.20	2/.25	1/.10	1/.20
Nevada							
Fallon		*	*	*	*	*	*
New Hampshire							
Concord	25,288	1/.19	1/.22	1/.17	2/.25	2/.29	2/.35
Ohio							
Mansfield	33,525					1/.19	1/.12
Xenia	10,507	2/.25	1/.15	1/.15	*		
Oregon							
Bend	8,848	*	2/.35	*	2/.25	1/.15	2/.25
Pennyslvania							
Pittsburgh	669,817		1/.15	1/.15			
South Dakota							
Brookings	4,376	2/.25	1/.15	2/.25	1/.15	1/.15	1/.15
		* * *	* * *	* * *	* * *	* * *	* * *
Tennessee							
Knoxville	105,802					2/.25	1/.10
Washington							
Raymond	3,828	*	*	*	*	4/.25	1/.10
						* * *	
Seattle	365,583	*	1/.15	1/.15	1/.15	2/.29	2/.25
Spokane	115,514	*	*	*	2/.25	1/.15	2/.15
Tacoma	106,817	1/.15	1/.20	1/.15	1/.15	1/.15	1/.15

Legend: _____, _ _ _ _, _ _, _ indicates shipped in from Cal., Fla., Tex., and Ga., respectively.
* None in market.
Local not underscored. * * * Shipped in. Source not indicated.
= Source unknown.

Table 17

Average Prices of Canned Peas

Sept. 1935--May, 1936

City	Average Price	City	Average Price
California	$ .20	Manitoba	
Calexico		Winnipeg	$ .19
Sebastopol	.20	Nebraska	
Connecticut		St. Paul	.18
Bridgeport	.19	McCook	.20
Georgia		North Carolina	
Atlanta	.19	Durham	.20
Illinois		New York	
Peoria	.23	New York City	.21
Indiana		Nevada	
Peru	.19	Fallon	.17
Iowa		New Hampshire	
Cedar Falls	.22	Concord	.23
Kansas		North Dakota	
Manhattan	.22	Ryder	.19
Maryland		Oregon	
Takoma Park	.19	Bend	.25
Michigan		Pennsylvania	
St. Clair Shores	.19	Pittsburgh	.19
Minnesota		South Dakota	
Duluth	.22	Brookings	.22
Missouri		Tennessee	
Kansas City	.20	Knoxville	.23
Montana		Washington	
Billings	.20	Raymond	.20
Washington, D. C.	.19	Seattle	.25
Hawaii		Spokane	.21
Honolulu	.23	Ohio	
		Xenia	.25
		Mansfield	.19

Table 21

Temperature Range of Refrigerators

in Various Stores

State	City	Outdoor Temperature High	Low	Range	Means of Refrigeration
Arkansas	Fayetteville	55°F.	42°F.	35°	Frigidaire
Alaska	Fairbanks	10°	-60°	34°	Only a room regulated by outside cold air
Colorado	Fort Collins	56°	28°	36°	Frigidaire
Florida	Gainesville	82°	30°	40-45°	Frigidaire
Hawaii	Honolulu	76°	65°	40°	General Electric
Idaho	Moscow			48-50°	Refrigerator window
Illinois	Urbana			50°	Ice-cooled refrigerator
Indiana	La Fayette			38-48°	Ice-cooled
Iowa	Ames			35-50°	Electric unit in ordinary refrigerator
Kansas	Lawrence	60°	7°	35-39°	Copeland Electric
Massachusetts	Amherst	41°	-11 °	33-34°	Owns Ammonia Belgium plant
Michigan	East Lansing	32°	14°	35°	Ice-cooled refrigerator
Minnesota	Minneapolis	30°	-30°	38°	Frigidaire
Montana	Fort Peck	38°	noon		General Electric and Kelvinator
Nebraska	Lincoln	62°	24°	53°	Frigidaire
New Hampshire	Concord	36°	18°	40-42°	Harmonia, Temperature set
Ohio	Columbus	53°	28°	40-44°	Frigidaire
Oklahoma	Stillwater	70°	30°	35-45°	Frigidaire
Oregon	Corvallis			45°	Frigidaire
Rhode Island	Wakefield			45°	Electric (In winter vegetables are stored chiefly in cellars.)
Tennessee	Knoxville	39°	26°	35-40°	Frigidaire
Texas	Prairie View			35-40°	Frigidaire
Washington	Tacoma	62°	45°	35-40°	Frigidaire
Wisconsin	Madison	41°	11°	40°	Frigidaire