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EDITORIAL.

On the occasion of the first "birthday" of the Quarterly, it is appropriate again to draw attention to its purpose - the dissemination of accurate technical data to the various branches of the Australian food industry, and particularly, information about the results of investigations in the laboratories of this Division of the Council for Scientific and Industrial Research. It is also hoped that the Quarterly will assist in the technical education of junior members of factory staffs who are being trained for more responsible positions. Since only limited numbers of this periodical can be distributed, factory managers are advised to circulate each copy as widely as possible.

Past failures to make adequate use of existing facilities for the technical education of selected employees and to employ a sufficient number of well-trained scientists are being felt in several sections of the food industry, particularly the canning section, where the vastly increased demands occasioned by the war have resulted in an acute shortage of well-trained technical men. With few exceptions, this state of affairs has been common not only to the smaller firms but also to the larger firms the annual outputs of which are valued at many millions of pounds. Admittedly, for the time being very little can be done to rectify this defect, but the position must be borne in mind in the early post-war period.

The main jobs of the scientific staff, in co-operation with the managers and foremen, are to maintain certain quality standards in the products, to increase the efficiency of existing processing procedures, to devise ways and means of overcoming technical troubles arising from day to day, and to test new methods or new products. Since a big proportion of such jobs fall on the factory staff, it is doubtful whether they can be carried through with consistent success if managers and foremen lack the fundamental knowledge of the materials, equipment, and processes with which they are dealing. Lacking fundamental information, which can be gained only by sound technical education, these men tend to rely on "hunches" and trial-and-error methods, which, while sometimes conspicuously successful, all too often cause considerable waste of time and money.

Under present conditions in Australia, the only facilities which can be utilized to this end are those provided in some of the courses at technical schools and colleges, but the size and importance of the food industries warrant the provision of special courses in food technology. Such courses would possibly provide for the study of the outlines of food manufacture, scientific principles of food preservation, food analysis, industrial hygiene, public health, and nutrition, together with studies of the principles of operations employed in food processing, e.g., size reduction, mixing, evaporation, drying, sterilization, heat transfer, pickling, curing, cold storage, etc. By the inclusion of subjects such as physics, biochemistry, and general bacteriology, a comprehensive course could be set out to enable the training of either general food technologists, superintendents, or foremen in any of the food industries. With such facilities available it should pay the industry to select young men for special training in these fields. Their absorption into the food industries should have a marked influence in increasing the efficiency of these industries.

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NOTE ON FILLED AND DRAINED WEIGHTS OF CANNED VEGETABLES.

Unlike fruits, most vegetables increase in weight when canned. Vegetables which contain starch absorb water during and after processing and thus increase in weight, but water is also absorbed as a result of the osmotic effect produced by the higher content of soluble material inside the vegetable than in the surrounding liquid. With fruits the osmotic effect is in the opposite direction, the syrup tending to extract water from the fruit.

The drained weights of some canned vegetables, expressed as percentages of the filled weights, have been determined by the Fruit and Vegetable Preservation Research Station, Campden, England (Annual Report, 1939, p.23). They are presented in the following table :-

RESULTS OF CONTROLLED TESTS AT CAMPDEN AND IN CANNING FACTORIES.

(Drained Weights expressed as Percentage of Filled Weights).

Vegetable.	Method of Packing.	No. of Varieties Tested.	Drained Weights.	
			Range.	Average.
Beans: dwarf	Whole.	16	95-100	101
	Sliced.	16	101-110	105
Beetroot.	Whole.	7	97-104	101
	Sliced.	3	94-98	96
	Diced.	3	92-96	94
Broad Beans.	Ungraded.	2	96-106	101
Carrots.	Whole.	10	95-108	103
	Sliced.	2	98-105	103
	Diced.	2	98-104	102
Cauliflower.	Heads.	6	94-100	98
Celery.	Hearts.	4	88-100	95
Peas:immature.	Graded.	6	98-114	106
Potatoes.	Whole.	15	100-119	105
Turnips.	Whole.	9	98-102	100

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EXTENDING THE STORAGE LIFE OF APPLES BY THE USE OF SKIN COATINGS.

1. EFFECTS AND USES.

A very thin film of wax, oil, or other protective material placed on the skin of apples retards yellowing to a marked degree and reduces wastage from certain storage disorders. Treated fruit is also firmer, less wilted, and generally brighter in appearance than untreated fruit. Such skin coatings are particularly valuable for increasing the life of fruits in common or unrefrigerated storage and will also increase the life in cool storage of some varieties of apples.

Treated apples can also be cool-stored at temperatures above those at which certain disorders may be developed, without the reduction in storage life which usually follows cool storage at higher temperatures.

The life after removal from cool store is also increased by treatment. This effect is particularly valuable when fruit is cool-stored for long periods and marketed later in the year when atmospheric temperatures are often high.

The effect of such coatings is due to the fact that the diffusion of oxygen and carbon dioxide through the skin of the fruit is restricted and consequently its life processes are slowed down. When effective coatings are used, apples will retain their green colour for long periods at temperatures as high as 70°F.

2. THE TYPES OF COATINGS.

Waxes, certain vegetable and mineral oils, and dewaxed shellac have proved satisfactory as skin coatings for apples. Fruit treated with wax has a bright and attractive appearance, but films of wax alone are not as effective in prolonging the life of fruit as films in which other materials are incorporated. A film of oil is very effective but is too oily, and dewaxed shellac gives the fruit an unnaturally varnished appearance. The most generally satisfactory coatings which are bright and free from any stickiness are those formed from either an oil and shellac or from waxes and an oil.

3. METHODS OF APPLICATION.

The coatings are applied conveniently by dipping the fruit in solutions or emulsions of the selected materials, which, on drying, leave an almost invisible protective film on the fruit.

(a) Castor Oil and Shellac in Alcohol.

Alcohol is the only suitable solvent which can be used without causing injury to the fruit. Both castor oil and dewaxed shellac are readily soluble in alcohol, and one of the preparations recommended for coating apples is a solution of a mixture of these substances. All waxes and other oils are insoluble in alcohol and have to be emulsified in water with special soaps. The principal advantages of the alcoholic solution are that it is easy to prepare and dries rapidly. Therefore, large quantities of fruit can be treated with this preparation without special equipment for drying the fruit after it is dipped, and the grower can treat the fruit on the orchard. The only equipment required is a tank to hold the solution, several perforated dipping baskets or boxes, and a draining rack which drains back into the tank.

<u>Methods of Hand Dipping</u>.- After picking, the fruit is brought to the shed to be treated. It is gently transferred from the field case to the dipping basket which is quickly immersed in the solution, care being taken to submerge every apple. The fruit just sinks in this solution. After dipping, the basket is placed on the rack to drain for a short time. If several dipping baskets are used at the one time, each one can be allowed to drain for several minutes while the others are being filled and dipped thus making subsequent drying of the fruit more rapid. The fruit is then gently transferred to a case in which drying is quickly completed and in which it may be stored. The cases of wet fruit should not be stacked up for a few hours in order that the alcohol may evaporate readily. They should be raised off the floor during this by placing them on 3 in. x 2 in. battens. By this means, one man can treat 20 to 25 bushels of fruit per hour.

A suitable dipping tank in which the fruit can be treated in case lots would be 22 in. long, 14 in. wide and 16 in. deep and could conveniently be made from galvanised iron. A reinforced, specially smoothed bushel case fitted with handles makes a suitable container for dipping the fruit. The sides and bottom should be of two pieces chamfered inside and spaced about $\frac{1}{2}$ in. apart. The bottom pieces should be as thick as the sides and should have a number of $\frac{3}{8}$ in. holes bored in them for rapid drainage.

During use, the alcohol evaporates rapidly and the solution becomes more concentrated. Such higher concentrations may cause the subsequent development of core browning and alcoholic breakdown due to "smothering" of the fruit. To overcome this difficulty, alcohol should be added from time to time to bring the solution back to its original concentration, or only small quantities of the solution should be used at a time and the fruit dipped quickly. Alcohol is inflammable and the necessary precautions should be taken when the solution is being used.

(b) <u>Emulsions.</u>

The various emulsions are not as suitable for hand-dipping the fruit as the alcoholic solution because they dry much more slowly. If the fruit is treated by hand with wax or oil emulsions it must be spread out to dry either on wire or wooden trays or on paper. With most emulsions the drying time under these conditions may be three or four hours or longer. However, the recommended emulsions are less sticky than the castor oil and shellac and are easier to handle; they are not inflammable and do not evaporate appreciably during use.

These emulsions are very suitable for large-scale use in packing sheds where a machine for dipping and drying the fruit can be installed. In such a machine the fruit is fed from a hopper into a tank of emulsion from which it is carried by a roller conveyor through a hot-air drying tunnel. The emulsions cannot be prepared on the orchard but can readily be made commercially in a concentrated form requiring dilution with water before use. Methods for the manufacture of suitable coatings for fruit were published in the February 1942 issue of the Journal of the Council for Scientific and Industrial Research.

4. COST OF COATING.

The cost of the materials for the alcoholic solution of castor oil and shellac is approximately three shillings per gallon. If the solution, which is easily prepared, is made up in bulk at a central point in each district, the cost to the grower should not be much more than four shillings per gallon. One gallon of solution is sufficient to treat 25-30 bushels of apples. The cost of treatment including labour would be approximately threepence per case.

The cost of the concentrated emulsion would be about 7s.6d. per gallon from the manufacturer. As the concentrated emulsion is diluted with one part of water before use, one gallon will treat 50-60 bushels of apples. The cost of treatment for materials and labour would therefore also be about threepence per case.

5. RESULTS OBTAINED WITH COATINGS.

Experiments have been carried out with the various coatings in New South Wales, Victoria, and Tasmania. Beneficial results have been obtained in New South Wales by treating Jonathan and Granny Smith apples. After three months at 50°F., untreated Jonathan apples were wilted, yellow in colour, and had developed severe Jonathan spot and mould, whereas treated apples were less wilted, greener, firmer in texture, and generally in sound condition. Treated Granny Smith apples were green in colour and in sound condition while similar untreated apples were yellow in colour and had developed skin blemishes, core browning, and mould. The life of these varieties in cool storage and after removal from cool storage has also been increased by skin coatings.

In Victoria, skin coatings have also retarded wilting and yellowing and have considerably reduced wastage from Jonathan spot in Jonathan apples and from bitter pit in Granny Smith apples. In Tasmania, skin coatings have retarded wilting and colour development and reduced wastage from storage disorders. The varieties that have reacted favourably to treatment in Tasmania are Cox's Orange Pippin, Cleopatra, and Jonathan at cool storage temperatures, and Granny Smith, Democrat, Crofton, Jonathan, and Sturmer Pippin under common storage conditions. Considerable quantities of apples have been common-stored awaiting dehydration, and treated fruit kept longer and yielded a better dried product than similar untreated fruit.

6. RECOMMENDED COATINGS FOR APPLES.

(a) For Common Storage.

(i) A solution of 8 per cent. castor oil and 2 per cent. dewaxed shellac in alcohol or methylated spirits.

(ii) An emulsion containing 12 per cent. of castor, olive, or peanut oil.

(iii) An emulsion containing 8 per cent. of paraffin wax, 2 per cent. of beeswax, carnauba, or lac wax, and 2 per cent. of castor, olive, or peanut oil.

Each of these recommended dips will be quite satisfactory, except that the oil emulsions will leave a sticky film on the fruit. Until further experiments have been carried out with other varieties, it would be advisable to restrict the varieties to be treated in New South Wales and Victoria to Granny Smith and Jonathan. In Tasmania, the Granny Smith, Jonathan, Sturmer Pippin, Crofton, and Democrat varieties have reacted favourably to treatment when common-stored and could be treated commercially for common storage in that state.

Note: Varieties such as Sturmer Pippin which are susceptible to brown heart (carbon dioxide poisoning) should not be treated with a preparation containing shellac which increases the carbon dioxide content of the tissues. Either a 10 per cent. solution of castor oil in alcohol or 10 per cent. emulsions of oil or wax should be used for these fruits.

(b) For Cool Storage.

The life of fruit after removal from cool store can be improved considerably by treating the fruit before storage with a solution of 4 per cent. castor oil and 1 per cent. shellac or with 7.5 per cent. wax or oil emulsions. Thicker coatings will improve the fruit in cool store but are likely to cause injury after the fruit is removed to atmospheric temperatures higher than 55°F.

7. PRECAUTIONS TO BE OBSERVED.

In order to obtain best results and to avoid injury to the fruit as a result of treatment, only selected fruit should be treated. Large fruit, or fruit from light crops, and over-mature fruit should not be treated, as severe internal disorders and alcoholic flavours may result. The fruit should be picked just before the commercial picking stage and should be in a sound condition. Treatment should be carried out within a day or two from picking; it is particularly important with the earlier varieties that there should be little delay between picking and treatment. Every care should be taken to avoid mechanical injuries to the fruit during handling, and any damaged fruit should not be treated.

The higher the temperature the more effective is a given coating in restricting gaseous diffusion, thus slowing down the normal life processing of the fruit. However, the danger of development of alcoholic flavour and internal disorders is increased as the temperature rises. This means that the type and thickness of the coating used should be related to the temperature at which the fruit is held. For common storage temperatures up to 55°F. the recommended coatings would be safe; for temperatures from 55°-65°F. the strength of the emulsion or solution should be reduced by 25 per cent., and for temperatures over 65°F. the strength should be only half that recommended for common storage.

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VEGETABLE EXTRACTS.

Because of wartime conditions the quantities of vegetable and yeast extracts now available on the Australian market have been considerably reduced. The food value of these extracts is due mainly to their relatively high content of vitamin B, and in a lesser degree to the presence of meat-like flavouring substances.

Many different processes have been evolved and several patents taken out for the production of vegetable extracts from waste or surplus vegetable material. An outline of the processes for making yeast extract has been given in Food Manufacture, Vol. XI (1936), p.376.

> "Most of the processes for making yeast extract depend upon a partial digestion or autolysis of the cells by the enzymes of the yeast. In one process the dried yeast is ground up to rupture the cells as much as possible so as to liberate the enzymes, and it is then allowed to autolyse with the addition of a small amount of a suitable preservative such as sulphur dioxide, in order to prevent putrefaction."

> "The autolysed yeast is then extracted several times with hot water and the extract separated from the cells either by centrifuging or by settling and running off the supernatant liquor."

> "The collected extracts are then evaporated in an open jacketed pan, or preferably a vacuum pan, until a semi-solid mass results. The requisite amount of salt should be added when partially evaporated."

"If an open pan is used to evaporate the extract the final product will produce a cloudy solution due to the fact that some of the protein has been coagulated or denatured. On the other hand, if the evaporation is carried out under vacuum this is prevented, and a much better and more soluble extract is obtained."

"Often, for vegetables and yeast, the material is merely boiled with successive quantities of water, and the collected extracts treated as described."

"Other processes involve the partial breakdown of the vegetable tissues by boiling, preferably under pressure in an autoclave, with dilute hydrochloric acid. This operation achieves a similar result to the autolysis described for yeast. After extraction with two or three changes of water and finally pressing, the collected extracts are mixed and made neutral by the addition of the calculated quantity of caustic soda. In this way, common salt is formed in the extract, as the result of neutralization, and this obviates the necessity of adding salt after the evaporation."

It is desirable to use specially selected yeast strains which have the property of storing relatively large amounts of vitamin B_1. Special methods and equipment are required for their cultivation and it is also necessary to maintain their purity.

Surplus yeast stocks from breweries, if obtainable, should provide a good source of raw material, but it would be essential to remove the bitter flavouring substances first, by treatment with alkali.

Of the vegetables suitable for extracts, carrot, which is relatively high in vitamin B_1, is most commonly used. Asparagus, beetroot, cabbage, cauliflower, potato, radish, spinach, and turnips all contain fair amounts of this vitamin, but the question of their use for the manufacture of extracts will depend on the availability and cost of supplies. Some of these vegetables may prove to be unsuitable on the score of flavours in the finished product. Legumes such as peas, lentils, lima or haricot beans, and sprouted cereal grains, all of which contain considerably higher amounts of B_1 than most vegetables, should provide good sources of extracts rich in this vitamin but their use for this purpose would involve waste of valuable protein matter.

The value of these extracts will finally depend upon their vitamin B_1 content and on the amounts likely to be included in the diet. Because of their initially higher level of B_1, yeasts are likely to provide richer extracts than vegetables. Provided that the vitamin is extracted from the raw material without any appreciable loss, these extracts should provide useful sources of a vitamin in which present day diets are considered to be deficient.

PRESERVATION OF FISH: PART 3.

STORAGE OF FROZEN FISH.

The reasons for the adoption of certain well-defined practices for the preservation of fish in the frozen state can be better appreciated from a knowledge of the nature and causes of spoilage to which frozen fish is subjected and of the methods for reducing deterioration to a minimum.

SPOILAGE IN FROZEN FISH.

In a previous article in this series it was shown that spoilage of fresh unfrozen fish was mainly of a bacteriological nature. In frozen fish stored below about 20°F., bacteria are unable to multiply and bring about spoilage, and in such fish the deterioration is due to physical and chemical changes of non-bacterial origin.

Although freshly-frozen fish, when thawed immediately after freezing, show some slight changes in appearance it is almost impossible for the consumer to distinguish the cooked fish from similar unfrozen material. After relatively long periods of storage in the frozen state, however, certain changes in texture and flavour become readily apparent to the taster. In addition, the appearance of the fish may be altered as the result of loss of water during storage.

Changes in texture: Frozen fish tend to show "dryness" or toughness after cooking. This condition is not due to loss of water by evaporation, since it is evident even when there is no such loss, but is bound up with certain physico-chemical changes in the proteins of the muscle fibres.

Changes in flavour: Off-flavours in the frozen fish are most frequently due to development of rancidity in the fatty tissues in the areas immediately beneath the skin, but in fish stored for long periods, the flavour of the deeper non-fatty muscle may be adversely affected either by loss of aroma characteristic of the particular species of fish or by development of "stale", "boxy", or "cold storage" flavours.

Changes due to drying: The loss of water by evaporation produces the condition known as "freezer burn" in the surface layers.

METHODS FOR STORAGE OF FROZEN FISH.

In order to ensure that frozen fish will be of the best possible quality after storage and that the adverse changes referred to are reduced to a minimum, the following conditions should be observed during the various handling operations.

(a) Removal to Frozen Storage:

After freezing, the fish should be transferred to the frozen storage room as rapidly as possible. It is preferable to do any necessary glazing, wrapping, and packing into containers in a room held below freezing (32°F.), but provided that such operations are carried out without delay a room at about 40°F. could be safely used. In some overseas plants all operations from freezing onwards are carried out by means of a continuous chain system.

Frozen fish should be stacked as closely as possible, but this should not be done until the temperature of the frozen product is as low as that of the storage room. The temperature of the freshly frozen fish will depend on the freezing conditions, and generally the outer layers will be colder than the inner when freezing is completed. When the temperature of the freezing medium is higher than that of frozen storage it will of course be obvious that the temperature of the frozen product will be above that required for storage.

It is inadvisable to stack fish directly on the floor or too close to the walls and ceiling; a free air space of at least 1 inch should be allowed. In the actual stacks, however, close packing should be adopted.

(b) Prevention of Drying:

Loss of water from frozen fish can be reduced to a minimum by the following methods.

Glazing: Glazing is usually applied to whole fish but may be used for blocks of fillets. The method generally adopted is to immerse the frozen fish for one or two seconds in water at about 34°F. The thin film of ice which forms on the surface of the fish can be increased in thickness by re-dipping two or more times with a short interval between each dipping. Another method is to apply the cold water as a finely atomized spray. The ice glazes so produced are rather brittle and tend to crack during storage and handling. More flexible glazes which are less liable to crack can be prepared by incorporating about 1 per cent. of glycerine in the water or by the so-called eutectic mixtures containing phosphates and other salts.

Since the ice glaze will evaporate, its replacement will become necessary at intervals depending upon the rate of drying. For stacked fish it is often more convenient to reglaze by pressure spraying.

Another method sometimes used is to distribute finely divided ice or snow over and between stacks or between boxes of fish. In some American cold stores this operation is carried out by using a mechanical blower. A minor disadvantage in this method is the tendency of the ice or snow to cake around the fish thus making separation of lots somewhat difficult.

Wrapping: Materials used for wrapping should be highly resistant to the passage of water vapour, and it is important to specify this quality when ordering supplies from the manufacturers. Waxed papers are frequently used, but at low temperatures are liable to crack at bends and edges thus reducing their effectiveness against loss of moisture-vapour. The moisture-proofed proprietary cellophanes and other similar papers do not possess this fault and in addition are more suitable where a display of the product is desired. Various grades of these papers are marketed, but for fish to be stored for any length of time a good moisture-vapour proof grade is required.

It is very important to restrict access of air to the product by hermetically sealing the wrapper. In some cases the wrapper lining of a carton holding several blocks of fillets is sealed in this way.

Packaging: Cardboard cartons used for holding fish should be waxed on either one or both sides; this treatment has been found to be more effective than impregnation of the cardboard.

Control of temperature and humidity: The temperature, humidity, and rate of movement of the air in the storage room all influence the rate at which water is lost from the frozen product.

It has been clearly demonstrated by trials both under laboratory and cold storage room conditions that lowering of temperature reduces the rate of water loss. The practicability of using temperatures which are sufficiently low to eliminate drying cannot, however, be considered separately from the conditions necessary for reduction of spoilage due to changes apart from drying or from the method of wrapping. It will be shown subsequently that the lowest possible temperatures of storage are advantageous from all aspects of storage. At temperatures round about minus 20°F., the rate of drying is likely to be so low that the efficiency of the wrapping material is of far less importance.

If all other conditions are similar, air of low relative humidity will take up more water from the frozen product than air of higher relative humidity. The most practicable methods for maintaining high humidities in the air of a frozen cold storage room have been outlined in Vol.1, No.3 of Food Preservation Quarterly and are :-

(i) Installation of heavy insulation.

(ii) Reduction of the temperature difference between the refrigerant cooling surface and that of the air in the room by using a relatively large area of cooling surface.

(iii) Use of finely divided ice or snow amongst the fish.

(iv) Maintenance of high loading; the humidity is generally low in a very lightly loaded store.

(v) Avoidance of temperature variations. Fluctuations in temperature of the storage room should be reduced to a minimum, and on this account it is inadvisable to use such a room for any other purpose than storage. When temperature variations are permitted it is quite possible for fish held in hermetically sealed containers to lose water which will subsequently be condensed on the inner surfaces of the containers. The possibilities of this happening are reduced if moisture-vapour-proof wrapping papers are closely adherent to the surfaces of the fish.

(c) Preservation of Texture:

Excluding the effects of drying, the texture of frozen fish is better maintained at lower than at higher temperatures of frozen storage. In commercial practice, however, the storage life of most species of fish, as determined by their palatability, is terminated as the result of deterioration in flavour long before the texture is so affected that rejection on that score is warranted.

(d) Preservation of Flavour.

The development of off-flavours in frozen fish is markedly affected by temperature, and in general a reduction of about 18°F. will approximately double the time taken by the fish to reach a given level of spoilage due to changes in flavour. It is possible, however, for areas such as the relatively dark oily flesh beneath the skin to be quite unpalatable while the flavour of the deeper and lighter flesh remains unchanged. Because of their high oil content, the so-called oily fish such as mullet cannot safely be held as long as the true white fish like whiting. Even in the oily fish, however, there may be considerable fluctuations in oil content at different times of the year, and when the values are low the fish can be held for longer periods. The average limit for completely satisfactory storage is approximately as follows :-

Temperature of Storage °F.	Time in months.	
	White fish.	Oily fish.
10	3	1-2
Zero	5	3
Minus 20	8	5

It is possible, of course, to store fish for longer periods and still find that the average consumer will accept the product, but there is certain to be some deterioration. It cannot be too strongly emphasized that the highest possible quality should be maintained at all times.

The choice of storage temperatures will depend upon the required time for holding the fish, and, since their condition at the time of freezing is of vital importance, it should be so arranged that the least fresh lots are the first to be withdrawn from storage. When fish are purchased at the markets it is difficult to ascertain their previous history, and in such instances a fair idea of their condition at any time can be obtained by testing the palatability of sample lots removed from frozen storage. For storage periods of longer than one month it is advisable to use temperatures of zero or lower.

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SELECTION AND HANDLING OF PEAS INTENDED FOR FREEZING.

During the past ten years in America there has been considerable commercial development in the frozen vegetable industry. In the year 1940 the total production of quick-frozen vegetables was about 83 million pounds including 36 million pounds of peas. In Australia there has been, up to the present, a very restricted application of freezing for the preservation of vegetables , but there appears to be ample scope for the future development of this industry. In the coastal areas of Australia, particularly in proximity to certain fishing ports, equipment installed for the quick-freezing of fish might profitably be used also for the freezing of vegetables grown in these areas; in the inland areas the most suitable sites would be in vegetable growing districts close to the larger towns and cities. In such centres the development of locker cold stores similar to those which have been established in America during recent years would be possible.

In a paper entitled "Survey and Statistics of the Quick Frozen Pea Industry" published in Quick Frozen Foods, Vol.2, July, 1940, p.19, V. Katkoff discusses the following phases of this industry in America :-

"Varieties suitable for freezing: Desirable varieties must mature uniformly so that harvesting can be done by vine threshers, thus lowering the costs of handling. When scalded in the preliminary blanch prior to freezing, they should become brilliant green in colour and must be tender and sweet at the optimum maturity. There must be no tendency to split during scalding, cooling, and packing, or to develop off-flavours during the pre-freezing treatment."

"For areas where sudden hot spells may increase the rate at which the crop matures, varieties which do not rapidly become starchy are desirable, since starchy peas are said to yield an almost inedible frozen product. On the other hand, immature peas lack flavour and do not suit the restaurant or hotel trade because they collapse on the steam table."

The author then quotes a list of proven and promising varieties which have been subjected to trials throughout several States in U.S.A. These trials, together with breeding and testing of new varieties, are carried out by the various Agricultural Experiment Stations and also by several commercial seed growers.

Of the varieties listed by the author as being satisfactory, Alderman, Telephone, and Stratagem are grown in Australia but not on a commercial scale. However, the Greenfeast variety which is being grown here has been found to give a palatable product. Generally, the varieties suitable for canning are unsuitable for freezing.

Method of harvesting: Of the numerous factors affecting the quality of frozen peas, the maturity at picking of the raw material is outstanding and is one of the most difficult to control because of its dependence on climatic conditions. Close attention to proper maturity is essential, especially if the vines are mowed at harvest. Peas of the most desirable and uniform maturity can be obtained by hand harvesting. Frequent picking will minimize over-ripeness. Since density of foliage may affect colouring, preliminary maturity determinations generally include examination for fullness of pods, age of pod, and appearance and flavour. Experienced packers can usually determine the maturity by the manner in which the peas crush when pressed by the fingers."

The tenderometer for automatically registering tenderness is a useful instrument developed by the American Can Co.

At the present time in America all peas commercially grown for freezing are cut down by tractor-drawn harvesters similar to those used for mowing grass, hand harvesting being used only for the fresh pea market.

"Handling of peas after harvest: Peas deteriorate rapidly at high temperatures following harvest, and studies showed that they cannot be depended upon to yield a high quality frozen product if held in the pod more than 6 hours at an average temperature of 70°F. or 48 hours at about 32°F. In practice, unshelled peas are not held longer than 8 to 10 hours at ordinary atmospheric temperatures but may be stored several days at 32°F. with an 85-90 per cent. relative humidity. Where the producing areas are some distance from the packing plants, peas in the pod are stored by covering them with crushed ice immediately after vining."

"Peas may be shelled by a mechanical device (referred to in the article) and the vines and shells are used for ensilage. This operation greatly increases the microbial contamination on the shelled peas which may be entirely spoiled in less than 24 hours at 70°."

"Since shelled peas, as well as those in the pod, generate a considerable amount of heat through respiratory processes they are held in relatively small masses."