FOOD PRESERVATION QUARTERLY.

Vol.2. No.2. June, 1942.

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Issued by

DIVISION OF FOOD PRESERVATION.

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

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THE DETERMINATION OF THERMAL PROCESSES FOR CANNED FOODS.

In a previous number of this quarterly (December 1941) it was pointed out that, with the exception of acid products, canned foods were liable to spoilage by spore-forming bacteria, the spores of which may survive the heat process given to the can.

The heat processes required to destroy these bacterial spores in canned foods may be calculated when the following information is available.

1. The times required at various temperatures to kill a definite number of spores when they are heated in the product. These are known as Thermal Death Times and further details of their determination will be discussed below.

2. The rate of heating and cooling of the contents of the can during processing. This involves the measurement of temperatures within the can while the cans are in the retort. The information so obtained may be plotted to construct a Heating Curve.

In order to show more clearly why these measurements are required, the methods by which "thermal death times" and "heating curves" are obtained will be described in turn.

Thermal Death Times.

When bacterial spores are subjected to a lethal temperature they do not all die simultaneously, but gradually die in such a manner that a constant percentage of the survivors is destroyed in a given interval of time, e.g. 50 per cent. may be destroyed every minute or 90 per cent. every hour, etc. Under these conditions it will take longer to destroy the last spore when the initial number is larger rather than small. Therefore in the determination of "thermal death times" it is important to use a known number of spores per unit volume.

The rate at which the spores are destroyed depends on the following three factors :-

(a) The inherent resistance characteristic of the type of spore. Under the same conditions some types of spores may survive for a period over 100 times as great as is required to destroy other types of spores.

(b) The temperature - the rate of destruction increases with the temperature.

(c) The composition of the product in which the spores are heated.

As all three factors are of major importance it must be remembered that "thermal death times" determined for various temperatures apply only to the particular organism and to its resistance in the particular product in which it is heated.

The actual determination of "thermal death times" is done by heating known numbers of spores of a particular species. The spores are suspended in the product which is dispensed in small quantities (1/20 to 1/5 of an ounce) in containers so that the spores can be heated very rapidly to the test temperature. After exposure to the temperature for various times the containers are cooled and the material cultured to test for the presence of surviving spores. In this manner the time required, at a given temperature, to destroy these spores may be determined.

The following table gives some typical figures for death times at various temperatures. The figures are for a heat-resistant strain of Clostridium botulinum, the toxin of which causes botulism. The times given are the minimum periods required to destroy 50 million spores of this organism when suspended in a phosphate solution of neutral reaction.

Minimum Destruction Times for Cl. botulinum after Esty and Meyer.

Temperature (°F.)	Time (minutes)
248	5
239	12
230	36
221	120
212	360

It is noteworthy that although the spores are killed rapidly at higher temperatures they may be destroyed equally well by prolonged heating at lower temperatures. It will be noted however that a decrease in temperature by about 18°F. increases the death time about ten-fold.

When the death time has been determined at several temperatures, the resulting points may be plotted to construct a Thermal Death Time Curve. Such a line represents those combinations of time and temperature which will destroy the spores.

For applications of these data to process calculations it is frequently more convenient to plot the reciprocals of the "thermal death times" against temperature, giving a temperature-lethal rate curve.

Heating Curves.

In measuring rates of heating, thermocouples are almost always used for determining temperatures. They may be made of quite fine wire and fitted to cans without making the can or pack seriously abnormal, and the leads can easily be led through a plug in the wall or lid of the retort to a measuring instrument outside it. It is generally sufficient to use one thermocouple in each can, with the junction placed so as to give the temperatures at the slowest heating point. It is usual to use several test cans in each run because there may be appreciable differences between cans due to slight differences in packing.

The temperatures at the thermocouple junctions are measured during retorting and subsequent cooling, and "heating curves" are obtained by plotting the measured temperatures against the times at which the readings were made. A "heating curve" will, of course, only apply to the particular can size, retort temperature, initial can temperature, and method of packing used in the test cans in which it was measured.

Calculation of Process.

When the "heating curve" and the "thermal death time curve" or temperature-lethal rate curve are available, it is possible to calculate the process time necessary to sterilize the pack. The most direct method is to plot the lethal rates (reciprocals of death times) corresponding to a number of points on the heating (and cooling) curve against the time, and draw a curve through them. The area under this curve, which is best measured by means of a planimeter, gives a measure of the total killing effect of the process. "Heating curves" for shorter or for slightly longer process times can be readily constructed from the measured heating curve and the killing effect of these modified processes determined in the usual way. By interpolation the minimum time necessary to destroy all spores can then be calculated.

When it is desired to calculate equivalent processes for different retort temperatures can sizes etc., the direct method outlined above is not very easy to apply, but reasonably convenient mathematical methods of deriving the desired values from the geometrical constants of the heating and thermal death time curves have been worked out.

Such calculated processes are, of course, only as accurate as the information on which they are based. It is usually desirable to obtain a further check on the calculations by using canned packs specially inoculated with heat-resistant spores. Such inoculated packs are then given the calculated process and others above and below the calculated one. The cans are then incubated at a suitable temperature and tested for any evidence of spoilage.

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CAN SEAMS AND CLOSING MACHINE ADJUSTMENTS.

During the past six months we have received in this laboratory a large number of sanitary type double-seamed cans showing evidence of leakage of the can contents through the seams at one or both ends of the can. In most cases the canned product has been spoiled, and, where it has been possible to ascertain that the heat process employed by the canner was sufficient to sterilize the particular foodstuff, there was clear-cut evidence that infection had taken place after the completion of processing. In other instances where the heat processing was known to be somewhat inadequate it has been difficult to determine whether the leaky seams may have been caused by subjection to heavy strains due to gas production by bacteria growing inside the can. In general, the evidence so far obtained indicates that the greater proportion of leaky seams in the cans which we have examined were due to initially poorly formed seams.

Principles of good seaming practice. The principles of good seaming practice have been well defined as the result of experimental work by several American can manufacturers and particularly by the Dewey and Almy Chemical Company, and the packer of canned foods has much to gain by co-operating with his can supplier in a study of the essentials of correct seaming. The chief points which have been brought out in various publications by Dewey and Almy are :-

(1) Can closing machines as supplied by manufacturers are built to give highly accurate seams, but since these machines require periodical adjustment, the possibility of error due to the human element is introduced.

(2) Adjustments of can closing machines can be made more unfailingly and difficulties remedied more quickly if the packer has a clear picture of the type of seam produced by any deviation in seamer adjustments. Attention to seaming procedure enables the packer to secure in his daily operations the full value of the dependability of his can and double seaming equipment.

(3) It is specially stressed that a good seamer-man will make frequent examinations of can seams and repeat these examinations after any necessary adjustments in the closing machines.

Methods for examination of seams. In order to make an adequate examination it is necessary to tear down the can seams and observe the degree of wrinkle in the cover hooks and also the condition of the sealing compound. In addition, it is essential to study the contour of the seam and the position and shape of the hooks as shown in cross sections of seams prepared as follows:- By means of a jeweller's saw, a cut which is perpendicular to the seam is made to extend about half an inch from the seam in each direction on the end and side of the can. A further cut is made about one quarter of an inch distant from the first cut and at such an angle that the two will join to form a triangular shaped section which can be pulled out, taking care not to damage the seam by excessive force. The right-angle cross section is then polished with emery paper to remove burrs from the saw, and finally treated by pressing on plasticine to remove fine particles of metal from the grooves of the seam.

The seam is then examined by means of hand lens giving a magnification of from 5 to 15 times.

Types of seams. The three basic operations in double seaming are base-plate or lifting pressure, first operation, and second operation. Since each of these may be either loose, normal, or tight it will be seen that there are twenty-seven possible combinations, each resulting in a differently formed seam.

Other variables which may affect the finished seam are tin-plate thickness, roll contours, chuck taper, curl of ends, dimensions of flange etc. but these, while affecting the general shape of the seam, do not materially affect changes brought about by varying closing machine adjustments.

Where it is desired to separate the effects of first and second operations, examinations should be made of cross-sections after the first operation is completed.

An adequate description of different types of seams is impossible without the aid of drawings or photographs. Since these cannot be reproduced in this quarterly the reader is referred to the publications listed at the end of this article.

Relation between type of seams and tendency to leak. Even a perfectly seamed can under vacuum is subject to strain because of the pressure exerted on the can by atmospheric forces. In addition, the cans are subjected to strain during handling and may be damaged by denting.

Dewey and Almy have demonstrated the following important points:-

(1) A well formed seam will withstand abuse such as denting just below the seam, whereas a poorly formed seam, although not definitely leaking, may be seriously affected and develop leaks under similar conditions.

(2) Even obviously malformed seams may not leak because of the protective effect of the compressed film of sealing compound.

In our laboratory a study has begun of the tendency of various types of seam to develop leaks both before and after rough handling of the cans. So far, the seams found most likely to develop leaks were those in which the second operation was loose. Dewey and Almy point out that tight second operation rolls may cover up faults of the first operation but lead to trouble at the lap, as well as heavy wear on the equipment.

Testing for leaks. The most practical test is to subject the closed can to an increased internal pressure and watch for the appearance of bubbles when the can is immersed in water. By means of a pressure gauge inserted into the can, the pressure at which leaks develop can be measured. It is important that the cans are not subjected to pressures sufficiently high to cause buckling, otherwise leaks which would not ordinarily develop may appear. The limiting pressures to which cans of different dimensions may be subjected without excessive strain on the seams due to buckling have been stated by Cruess to be :-

Can No.	Dimensions in.	Buckling Pressure lb.
10	6 3/16 x 7	10-15
3	$4\frac{1}{4}$ x $4\frac{7}{8}$	15-20
2	$3\frac{7}{8}$ x 4 9/16	30
	$3\frac{7}{8}$ x $5\frac{3}{4}$	"
	$3\frac{7}{8}$ x $6\frac{1}{4}$	"

The points at which leaks appear should be marked and the corresponding pressures recorded. Cross sections of the leaky areas should then be examined as previously described. We have had numerous instances of leaks developing at less than 1 lb. positive pressure.

When cans containing food are to be tested it is of the utmost importance that the food should be removed from the can - through a hole cut in one end - and the can thoroughly rinsed and boiled for one hour in water, then drained and dried before examination. This procedure is necessary to facilitate the removal of food particles which may block up the leaky areas. In addition, blockage may be caused by corrosion or rusting, in which case the particles may be less easily removed by this treatment.

For the reasons stated, failure to detect leaks by this method should not be taken as a clear indication that the can had not developed leaks at some stage after the completion of retorting.

In the absence of a pump or a supply of compressed air, a positive pressure may be developed in the can by immersing it in hot water.

Recommendations. The canner who does not make or assemble his own cans is dependent upon the can manufacturer for the reliability of the seams at one end of the can, but depends on the efficiency of his own operators and particularly on the correct adjustment of closing machines in his own factory for the other end. Our experience has been that badly formed seams are far more frequently found in the canner's end of the cans.

While it has not been possible to obtain an accurate estimate of losses due to leaky cans, it is obvious that, under present conditions, waste of tin-plate, foodstuffs, and manpower should be reduced to a minimum. For these reasons a close study of can seams and of closing machine adjustments should be made both by can manufacturers and food canners.

The Dewey and Almy publications which have been quoted in this article are:-

"Closing Machine Adjustments" by E. G. Blake.
"Your Can Seams" by T. T. Miller.
"A Simple Method of Detecting Faulty Can Seams" by D. Stevens.

The Australian address of this firm is 30 Abbotsford Street, North Melbourne.

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THE USE OF BLACK-PLATE CONTAINERS FOR HONEY.

The suitability of black-plate containers for the storage of honey has been tested in this laboratory. Samples of honey, both clear and candied, were stored at a temperature of 100° F. in four-gallon mild steel drums, coated internally with beeswax, alongside control samples of the two honeys packed in glass jars.

When examined after storage periods of one month and two months, palatability and colorimetric tests did not indicate any significant difference between the honeys packed in black-plate and those packed in glass. There was no evidence of deterioration in the quality of the honeys or in the properties of the black-plate containers.

On the results of these laboratory tests it is considered that mild steel drums coated internally with beeswax are worthy of extensive commercial trials as containers for honey. In such trials the following points should be observed :-

1. Rough handling during transport may fracture the beeswax lining and expose the base plate. However, in view of the robustness of the containers and the flexibility of the lining this contingency is not likely to be a serious one.

2. The melting point of beeswax is approximately 140° F. The containers should not be stored under conditions in which temperatures of this order may be reached, e.g. in direct sun or in ships' holds near the engine room.

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THE PRESERVATION OF FISH: PART IV.

THE HANDLING OF FISH AFTER FROZEN STORAGE.

After removal from frozen storage the fish will be distributed through various channels depending upon the facilities available for marketing. Under ideal conditions the consumer will be able to purchase fish still in the hard-frozen condition, but this will only be possible where adequate refrigeration is available at all stages during distribution. It is not customary to sell frozen fish in the open fish markets because it is difficult to avoid thawing of the fish under these conditions, nevertheless, such fish should keep as well as unfrozen fish packed in ice.

Under Australian conditions the most satisfactory channels for distribution of frozen fish are through hotels, restaurants, and institutions which can handle relatively large consignments within a short period. When the storage rooms holding frozen fish are situated some distance away from the area for marketing, it will be necessary to keep the fish as cold as possible during transport.

Packing and Transport.

The procedure adopted in packing and transport will depend upon such factors as the time required for holding the fish before consumption, seasonal conditions, and the facilities for refrigeration during transport. At present there is practically no provision in Australia for the carriage of frozen products in road vehicles or railway vans which can be mechanically refrigerated and held at temperatures below 32° F. The railway vans used for the transport of frozen meat and butter are ice-cooled and well insulated and are generally filled with the frozen product; these could be used for fish provided that they were filled to capacity.

Frequently, however, there are only small lots of frozen fish to be carried at one time, and in these cases the fish may be kept in the frozen state by the inclusion of dry ice in the container which may be of corrugated cardboard. An alternative method is to pack the frozen fish in ice, but this would permit slow thawing and would not be satisfactory for fillets packed in paper coverings. The use of a specially built wooden box insulated with several inches of an efficient insulating material such as cork may be warranted where a regular supply of frozen fish to distant markets can be maintained.

When the time required for holding is no longer than one day, a close packing of the frozen fish into a corrugated cardboard container may be all that is necessary.

Spoilage of Thawed Fish.

Thawed fish are susceptible to spoilage in the same manner as fish which have not been frozen. Some of the bacteria present on the fish at the time of freezing are able to survive long periods of frozen storage and to begin multiplication on the thawed fish; these will bring about bacterial spoilage as outlined in a previous article of this series.

During thawing there is also some loss of "drip" or muscle juice which varies in amount with the species of fish, the rate of freezing, and several other factors. The loss of drip is not so noticeable in unfilleted fish but it may be of the order of 10 per cent. in fillets which have a relatively large area of exposed cut surfaces from which the flow of drip takes place. Since this drip may soak through the wrapper and into the container, it is preferable to maintain the fish in the frozen state right up to the time of passing them over to the consumer.

The storage life of thawed fish can be extended for a day or more by packing in ice, but such fish could not be kept so long as fresh unfrozen fish which are iced soon after catching.

Thawing of Frozen Fish.

From the standpoint of palatability in the cooked product, it has been demonstrated by research workers in Canada, England, and also in this laboratory that the best results are obtained if fish are cooked whilst still in the frozen condition. When allowed to thaw before cooking there is an inevitable loss of "drip" or muscle juice which carries with it some of the soluble flavouring constituents, thus rendering the thawed fish drier and less palatable than those cooked whilst still frozen. Because of the inadequate facilities for holding fish in the frozen condition right up to the time of retail sale in Australia, it is impossible to ensure that the consumer will receive the fish before they have been thawed. There are times also when it will be necessary for the wholesaler or retailer to thaw out lots of fish before they can be satisfactorily handled.

The most suitable method of thawing will depend upon the treatment given to the particular lot of fish during freezing and storage and the use to which the thawed fish are to be put. Generally the best results are obtained by thawing rapidly and as uniformly as possible so that the particular lot of fish will be ready for disposal at short notice. When slowly thawed, for example in boxes held at ordinary air temperatures, it is possible for the thawed outer fish to become spoiled while the inner fish remain in the frozen state. In boxed fish a more uniform thawing can be obtained by removing the frozen fish and spreading them out in a single layer, but if the fish have been frozen in a solid block other methods are necessary. The conditions necessary for thawing of boxed fish have been outlined in Modern Refrigeration, Vol. 43, October 1940, by C.L. Cutting of the Torry Research Station, Aberdeen. Using one stone (8 lb.) boxes about three and a half inches in depth filled with white fish fillets, the times taken for thawing in running tap-water were :-

Time (hours) in running water.

	40°F.	60°F.
One stone (in box)	22	12
" " (out of box)	16	8

Comparison was made between thawing in water and in air at various temperatures and velocities, and the conclusion was reached that, provided water-logging is avoided and also the sticking together of large numbers of fish, the better product is obtained by thawing in water, superficial drying being avoided and the time required for thawing considerably reduced.

"The time required and the trouble entailed in thawing frozen fish could be considerably reduced if the customary methods of packing were altered. For example, when layers of fillets were packed with a sheet of waxed paper or three sheets of parchment paper between them, the frozen "fillets ($1\frac{1}{2}$ in. thick and 2 lb. in weight) could be satisfactorily separated without tearing the fish, and then could be thawed separately, taking in water at 60°F. about half an hour and in air at 60°F. about 4 hours. The use of paper between the fish, which makes practically no difference to the rate of freezing, would make it possible to send one-stone boxes of fillets to the retailer, restauranteur, or fish-frier, in the frozen condition, the separate fillets being thawed quite rapidly on arrival or cooked whilst still frozen."

"Removal of the insultating wooden box from the frozen block of fish reduces thawing time by about one-third. It is essential to remove the fish from the water immediately they have thawed, otherwise "water-logging" due to uptake of water by the flesh is detrimental to appearance and texture." When adopted on a large scale the thawing tanks contain a frame-work of racks to keep the blocks of fish separated.

"Smoke-cured fish also could be thawed in water. Both kippers and finnan haddocks present a satisfactory appearance, provided they were laid out on a tray to allow the moisture adhering to the surface to evaporate. Moreover, since smoke-cured fish are less closely packed in boxes than wet fish, water can get into the air spaces and thawing can proceed faster, especially if the block is tapped or the fish pulled apart. In fact, if the fish are suitably packed before freezing, they may be separated in the frozen condition by the retailer, or can be sent in that condition to him; single kippers can then be completely thawed out in less than ten minutes in running tap-water at 60°F., or in about an hour in air at the same temperature."

"Greater speed in thawing and in freezing can be obtained by abandoning traditional methods of packing, so that the thickness and insulation of the package are reduced to a minimum. Thus the fish can be frozen in metal moulds about $1\frac{3}{4}$ inches deep, frozen rapidly in brine or less rapidly in air, the blocks of fish being then stored in piles in large wooden boxes after removal from the moulds and "glazing". Thawing of such blocks was found to take place in 6 hours in air at 60°F. and in $1\frac{1}{2}$ hours in water at 60°F. The frozen blocks of fish might well be distributed to retailers in the large wooden storage boxes."

Blocks of frozen fillets of regular dimensions may be rapidly thawed by placing them in a metal dish which is floated on water or by packing in a water-tight open-mouthed metal container the sides of which fit closely in contact with the blocks when the container is suspended in a tank of water.

Cooking of Frozen Fish.

As previously stated, frozen fish are best when cooked whilst still frozen and, when this is done, only a slightly increased cooking time is necessary.

Cutting states that there is no greater tendency for sputtering in frozen fillets dipped in batter and plunged immediately into the hot fat for frying than when unfrozen fillets are used.

Fish which have been held for long periods in the frozen condition tend to be rather dry and are improved by being cooked in batter or in closed dishes; they can also be made up in the form of fish cakes.

Since consumers are likely to be unfamiliar with the methods for cooking frozen fish, it would be advisable for the distributors to supply the necessary details either on the wrappers or by other means.

Completion of Series of Articles on Fish Preservation.

This article is the final one of the main series on the preservation of fish. The attention of readers is drawn to the recent issue by the Division of Food Preservation of a Circular 4P entitled "Notes on Application of Refrigeration to the Australian Fishing Industry", (1942). This can be obtained on application to The Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne.

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THE PRESERVATION OF CITRUS PEEL.

Some time ago this Laboratory was asked to assist in devising a method for retaining a light colour in citrus peel. It was pointed out that in current industrial practice a very considerable darkening of citrus peels occurs during manufacture.

On 1st May, 1941, three sealed jars of orange peel were put down as follows :-

(a) In two jars the peel was immersed in a liquor containing 2.7 per cent. potassium alum and 4.1 per cent. sodium metabisulphite, equivalent to 2.3 per cent. sulphur dioxide.

(b) In the other jar, the liquor contained 2.7 per cent. potassium alum and 0.9 per cent. sodium metabisulphite, equivalent to 0.5 per cent. sulphur dioxide.

The jars were opened on 15th May, 1942, after one year's storage at ordinary temperatures. The following figures were obtained for the concentration of sulphur dioxide in the liquors.

	Original Concentration.	Concentration after 1 year.
1.	2.3 per cent.	1.52 per cent.
2.	2.3 " "	1.84 " "
3.	0.5 " "	0.17 " "

The peel in all treatments was bright and attractive in appearance and firm and flexible in texture. The peel in the liquors originally containing 2.3 per cent. sulphur dioxide was significantly lighter in colour than that in 0.5 per cent. sulphur dioxide. In general, the appearance of the experimental peels was considerably superior to that usually encountered in current industrial practice. This was probably due to the higher concentrations of sulphur dioxide used. However, the fact that the peel preserved in 0.5 per cent. sulphur dioxide, which is of the order of the concentrations used at present, was also of superior appearance, indicates that another factor was operating. This factor was probably the holding of the peel in tightly sealed containers throughout the storage period.

The results of this experiment should suggest to processors some ideas on how to improve the colour of citrus peel.

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THE DETERMINATION OF MOISTURE IN DRIED VEGETABLES.

It has been found, both here and in other countries, that dried vegetables must have a low moisture content if they are to retain their initial vitamin content and palatability for even relatively short periods of storage. The moisture content is particularly important if the dried vegetables are required for use in tropical or sub-tropical climates.

The determination of the moisture content of dried vegetables presents difficulties, because some vegetables decompose rapidly at temperatures in the vicinity of 100°C. A temperature of about 70°C. causes much less decomposition, and if the drying is hastened by using a diminished pressure, satisfactory results are obtained. Thus all specifications for the moisture content of dried vegetables are based in the first instance on the figures obtained by drying the material to constant weight at 70°C. at a pressure corresponding to 100 mm. of mercury or less. In the present circumstances, however, it is difficult to obtain the equipment required for this method, so that several alternative methods have been investigated. As a result of this work, drying in air at 96°C. for 16 hours has been adopted as the standard method in Australia and the following specification drawn up :-

Standard Method for the Determination of Moisture in Dried Vegetables.

The sample shall be ground to a fine powder in a hand-operated or power-driven mill and the procedure shall be such that there is no appreciable heating of the mill surfaces. The whole of the ground material shall be used, without sieving, for the determination of moisture. This procedure shall apply to all dried vegetables except dried onions and dried tomatoes which shall be broken up slightly by hand. Amounts of 20 g. ± 0.5 g. shall be weighed accurately into tared tins with tightly fitting lids. The depth of the tins used shall not exceed one inch and the diameter shall be not less than 3 inches nor more than 3.5 inches. The balance and weights used shall be such as to give an accuracy at least equal to 0.01 g. The tin containing the ground material shall be heated, along with the lid, for exactly 16 hours at 96°C., using an unlagged steam oven fitted with a reflux condenser, or a thermostatically controlled electric oven. The maximum variation in temperature shall be ± 1°C. The lid shall be replaced on the tin as it is withdrawn from the oven and the tin and contents weighed 15 minutes after withdrawal from the oven, or, if a desiccator is available, the tin and contents shall be allowed to cool in the desiccator and weighed. The result shall be expressed as a percentage of the weight of ground dried vegetable taken.

In most cases the figures obtained by this method will be different from those obtained by the vacuum oven method and the maximum moisture contents allowed in certain dried vegetables are given below as an illustration :-

Vegetable	Maximum Moisture Content (per cent).	
	Vacuum Oven at 70°C. (const. wt.)	Air or Steam Oven at 96°C. (16 hours)
Cabbage	6	10
Carrot	6	8
Onion	6	12
Parsnip	6	7
Potato	9	9

In addition, a more rapid method is desirable for process control, and an investigation of methods suitable for this purpose is proceeding.

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ASCORBIC ACID (VITAMIN C) IN WILD ROSE HIPS.

The hips or fruit of the wild briar rose (Rosa rubiginosa) are known to provide a rich source of ascorbic acid which has been prepared from them on a large scale in the U.S.S.R. for some years. They have also more recently been used in Britain for the preparation of ascorbic acid concentrates, two hundred tons of hips being processed during the year 1941. It was reported before the outbreak of war that in Germany wild roses were being planted along roads and railways with a view to utilizing the hips.

The possibility of making use of similar Australian material has recently been investigated in this laboratory, where the following factors have been studied:- availability of material, its ascorbic acid content, methods of processing, and the stability of the vitamin in various preparations.

Availability of material. The wild or briar rose has spread as a weed through the cooler parts of Victoria, the tablelands of New South Wales, and over the greater part of Tasmania, and considerable quantities of the fruit are known to be available in areas where collection would be practicable. Collection of the fruit on a large scale might be done, as in Britain, through organizations such as Boy Scouts and Girl Guides who could be encouraged to do the work from patriotic motives. In Britain an additional incentive was offered through payment of two shillings per stone of fourteen pounds.

In Britain, fruit from all over the country was sent to a small number of centrally located factories. In Australia, the lay-out of the railway systems would probably make Sydney, Melbourne and Hobart the best centres for this purpose.

The fruit should be picked ripe, but not mushy, and processed as soon as possible.

Ascorbic Acid Content of Australian Material. Figures for the ascorbic acid content of rose hips from a number of Australian localities are given in the following table :

Source of Fruit		Ascorbic Acid mg. per 100 g. of Whole Firm Fruit.
N.S.W.	Bathurst	517
	Goulburn	560
	Blayney	543
	North Shore	553
Vic.	Melbourne	453
	"	483
	"	495
Tas.	Sandfly	833
	Launceston	816
	Cygnet	781
	Summerleas	780
	Franklin	674
	Tamar	652
	Sorell	561

The Melbourne material was rather riper than the others and contained a considerable proportion of soft fruit; this may account for its lower level of ascorbic acid. Mushy fruit specially picked out from the Launceston sample showed between 270 and 310 mg. per 100 g.

In general, the values for ascorbic acid in the Australian rose hips are very high in comparison with the recognized vitamin-rich fruits such as oranges 55 mg., lemons 45 mg., and tomatoes 20 mg. per 100 g.

Processing. Rose hips in the natural state are quite unsuitable for human consumption but may be processed to form syrups, puree, or concentrates which can be mixed with jams and jellies of distinctive flavour to give palatable products of high ascorbic acid content.

The following methods have been used in Britain :-

Small scale preparation of rose hip syrup. Two pounds of hips are stewed for twenty minutes with two pints of water. The cooked puree is passed through a hair or stainless steel sieve; one and a half pounds of sugar are added for each two pints of puree and the mixture is boiled for ten minutes.

Factory scale preparation of rose hip syrup concentrate. The milled or cracked hips are placed in boiling water using about two parts by weight of water to one of hips. After extraction for half an hour the free liquor is removed in a hydraulic press, avoiding pressure high enough to press out a thick viscous extract. The bulk extract is roughly clarified where possible and concentrated in a vacuum pan to approximately one-seventh of its original volume. Syrup is added to bring the total concentration of sugar to 60-65 per cent. After the addition of sulphur dioxide at the rate of 350 parts per million, the product is stored in a cool dry place until the deposit settles and then filtered through diatomaceous earth. When a press is not used, more water can be added in the original extraction and the free liquor siphoned off.

The concentrate produced in this way contained about 5½ lb. of ascorbic acid for each ton of hips used. The original content of the fruit was not stated, but assuming a value of 500 mg. per 100 g., the yield is of the order of 50 per cent.

Methods in this laboratory. Rose hips were added to twice the weight of boiling water and boiling continued for five minutes. The fruit which was then quite soft was broken up and allowed to stand in the water for a further thirty minutes. The juice was squeezed through muslin and the residue re-extracted as previously. The proportion of ascorbic acid extracted in the second boiling, although variable, was always large enough to justify such treatment; at least eighty per cent of the ascorbic acid of the fruit was extracted in the two boilings.

The combined extracts were concentrated in the vacuum pan to a paste with an ascorbic acid content of 1200 mg. per 100 g. of 1.2 per cent.

Stability of ascorbic acid in rose hip preparations. According to Russian research workers, rose hip concentrates showed a gradual loss of potency when stored in factory containers for a year at ordinary air temperature. In one month the loss was approximately 20 per cent., six months 50 per cent., and twelve months 60 per cent.

The stability of preparations in this laboratory has not yet been extensively tested, but one sample of rose hip syrup containing 200 mg. per 100 g. retained about 80 per cent. of its potency after 77 days in a can at room temperature.

Method of Use. Rose hip concentrate can be taken daily as an antiscorbutic. Alternatively, it may be used to fortify other foods, of which for various reasons jam appears to be the most suitable. Rose hip syrups, which can easily be made at home in districts where the fruit is available, containing about 200 mg. of ascorbic acid per 100 g. would provide the estimated daily human requirements in one ounce of the syrup. If the syrup is used in this way it is important that it should not be used in large doses, since most of the excess ascorbic acid would then be wasted in the body which does not store this vitamin to any extent.

Assuming a yield of the order found in processing, and taking 30 mg. of ascorbic acid as the minimum daily requirement for one man, a ton of rose hips would provide a day's requirement for roughly 75,000 men. The amount of rose hips likely to be available in Australia will therefore not solve the problem of vitamin C supplies, although they may make a useful contribution in that direction.

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SUBSTITUTE COFFEE.

Because of the present scarcity of imported coffee, attention has recently been directed towards finding suitable substitutes. Using wheat as the cereal base, a simple and rapid method has been developed in this laboratory for producing a substitute at a relatively low cost for the raw materials.

Equal parts by weight of whole wheat grains and glucose syrup are spread out on a metal tray in a layer of about one-quarter of an inch in depth and baked for one hour in an oven at 390° F. After a short period in the oven, when the glucose has softened and become more fluid, the mixture is well stirred to ensure uniform distribution of the wheat through the glucose. After baking is completed the oven is turned off and the product allowed to cool therein.

The baked mass which should be very dark, almost black, is then ground in a coffee mill. Being somewhat hygroscopic, it should be stored in air-tight containers; under these conditions it keeps well for several weeks at ordinary temperatures.

The flavour of the product closely resembles that of certain cereal preparations which have been on the market for several years. Approximately 60 per cent. of the material is water-soluble and it may be used in the proportion of one heaped teaspoon to a cup.

It differs from true coffee in being free from caffein and therefore lacks the stimulant effect due to this substance.

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