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A progress report on a comparison of chilled and frozen beef under export conditions carried out by the Division of Food Preservation and Transport, C.S.I.R.O., at its laboratory at Cannon Hill, Q., as part of cooperative investigations involving also the New Zealand and United Kingdom Departments of Scientific and Industrial Research.

The Export of Chilled

EMPEY (1930) STATED THAT "WHEN PRIME young beef was used, it was difficult to distinguish in the cooked state between frozen and chilled portions of the same carcass." This referred to carcasses of animals from three to four years old. The same author gave detailed results of tests on "baby beef" using three specially fattened prime two-year-old steers on which the following processing procedures were compared on paired sides:

Two days' chilling at 38°F, ten days' freezing at 5°F, two days' thawing at 55-65°F, and a final one day's chilling at 38°F.

Fifteen days' chilling at 38°F.

Both steaks and roasts were examined. Briefly, the results were as follows: On inspection before cooking there was a slight preference for the appearance of the frozen samples owing to the fresher appearance of the fat, but the appearance of "drip" in the frozen steaks evoked adverse comment. In the cooked state the fat of the frozen beef was generally considered better in appearance and flavour than the chilled. In overall preference there was no difference between the chilled and frozen paired samples.

Moran and Bate-Smith (1929) carried out experiments in which the palatabilities of loin joints chilled, slightly frozen (at 28°F), and hard frozen (at 13°F) were compared on three occasions. On each occasion, a two- to three-year-old specially selected Aberdeen Angus bullock of highest quality was used. Storage periods were seven to eight days. Bate-Smith and Moran concluded that "freezing as such has no marked deleterious effect on the palatability of the meat".

The results obtained by Empey and by Bate-Smith and Moran were, however, based on very restricted data and on material which would not be considered truly representative of chilled and frozen beef imported into the United Kingdom from Australia or New Zealand, from the point of view of quality, freezing conditions, and storage times.

When the Meat Producers' Board of New Zealand decided to send a trial shipment of chilled beef to England on the *Dominion Monarch* in the latter half of 1952 the New Zealand Department of Scientific and Industrial Research took the opportunity of obtaining data on the palatability of chilled, frozen, and quick-frozen quarters transported under export conditions. Selected paired sides were examined in England by trained tasting panels from Messrs. J. Lyons and Co. and from the British Ministry of Food, and both panels found no significant differences in palatability (Anon. 1952). There again, however, only a small amount of material was examined, only three carcasses being available for making the three pairs of comparisons between chilled, normally frozen, and quick-frozen beef.

The trials described below were undertaken by the C.S.I.R.O. Meat Research Laboratory at Cannon Hill Abattoir, Brisbane, to supply a more reliable answer to the question of the differences between chilled and frozen export beef. Two trials were made. In both, direct comparisons of the results of chilling and freezing were made on paired quarters. In the first trial 10 carcasses were used and half were removed for examination 45 days after slaughter, the remainder seven days later. In the second trial 12 carcasses were used and four were removed at each of three intervals — 24, 45, and 66 days after slaughter. The handling of the material at preparation and removal was the same in both trials. As far as possible the work was planned so that all data would be suitable for statistical analysis.

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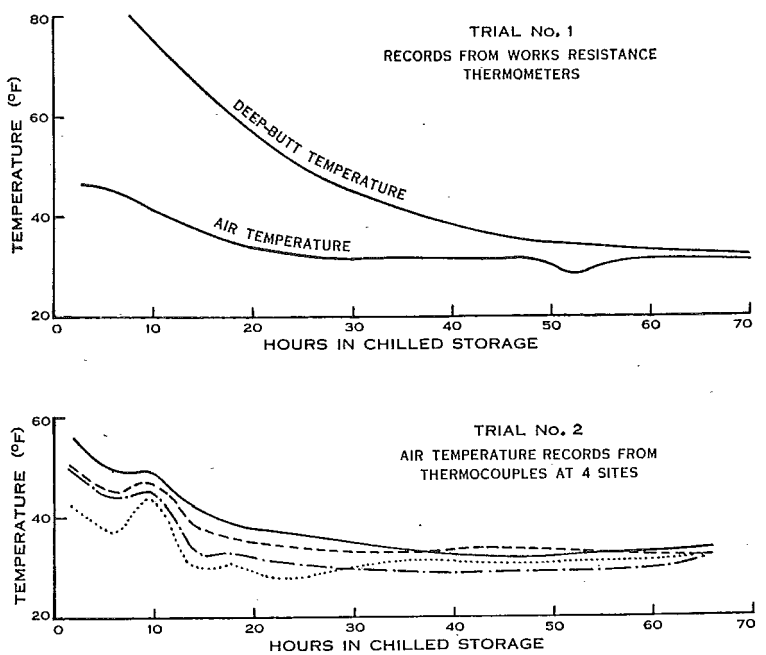
and Frozen Beef

PREPARATION AND STORAGE OF MATERIAL

The carcasses used were typical first-quality chiller grade. They were selected from the first beasts slaughtered on the day of kill at Borthwick's Meat-works at Moreton, about two miles from the Cannon Hill Laboratory. The conditions of slaughter were as close to those recommended for export chilled beef as could be obtained during slaughter operations for frozen storage.

After sawing down, one side from each carcass was allocated at random to chilling and the other to freezing. In trial 1 bacteriological samples were taken as soon as possible after the sides entered the chiller — aitchbone area and neck samples being taken from three pairs of carcasses. All sides were held in the chiller for 72 hours. Air temperatures and bone temperatures during chilling for trial 1 and air temperatures for trial 2 are shown in the graph below.

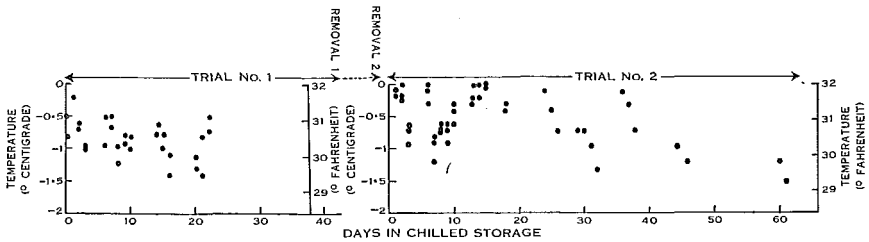
After the chilling period the sides were quartered and the quarters to be frozen were transferred to the freezer and frozen store in the normal manner, being held in store at 8-10°F. The quarters to be stored under chilled conditions were wrapped in two sterile



Air and deep-butt temperatures during chilling.

stockinet wraps and were then transferred a distance of two miles by truck, well covered with tarpaulins, to the laboratory, where they were placed in one of the gas-tight experimental cool rooms. This room had been thoroughly washed with soap and water and then fumigated with formalin. The quarters were hung in the cool room and the outer stockinet wrap discarded. Selected fores and hinds were weighed and placed in the middle of the stow.

Bacteriological samples were taken from the aitchbone and neck areas. After the door had been sealed, carbon dioxide was blown in. In the early stages of trial 1 the carbon dioxide in the storage atmosphere was allowed to fluctuate between 10 and 15 per cent. but later and throughout trial 2 it was kept at just over 10 per cent. Temperature was controlled during each trial but humidity was not. The actual temperatures and humidities are shown in the figures above and on the opposite page, the mean temperature being approximately 31°F.



Daily record of air temperatures during chilled storage.

REMOVAL OF MATERIAL

Three days before the proposed date of removal of chilled material from store, the appropriate paired frozen quarters were removed and transported to the laboratory. Bacteriological samples were taken and the quarters were placed in a room at 50°F where they were allowed to thaw for 72 hours. At the end of the thawing period the gas-tight room was opened, weight loss measurements made on the chilled quarters, bacteriological samples taken, and the required quarters removed. The room was then resealed and the carbon dioxide concentration restored.

The chilled and thawed quarters were compared for appearance, broken into butchers' cuts on a band-saw, weighed, and then hung for 24 hours at 50°F to allow the "drip" to exude. They were then reweighed and the paired cuts examined. Samples were taken for cooking and other tests. For the cooking tests a rolled roast was prepared from each forequarter, using the eighth, ninth, and tenth ribs. The roasts were prepared by boning out the ribs, trimming off extra-muscular fat, and rolling. The standard length of roll was cut off for cooking and then weighed. After preparation the joints were held at 30°F till cooked. For cooking the paired joints were placed, with fat, in stainless steel trays side by side in an electric oven and allowed to cook until the temperature of the centre of the roast reached 190°F as measured by a thermocouple inserted in each roast. The oven temperature was held at 350°F by means of a thermostat. After cooking the roasts were weighed, allowed to cool, and then held at 30°F till the next day, when they were served cold to a panel of trained tasters.

A steak $\frac{3}{4}$ in. thick was cut from each rump after the exposed cut surfaces had been removed, and the paired steaks were placed on a wire-mesh tray in the oven at 550°F and cooked until the centre temperature reached 190°F. When cooked in this way the steaks had the appearance and flavour of a normal grill. The steaks were served hot to the tasting panel.

The panel consisted of nine members who had been trained to score the various attributes of palatability on a scale which they had memorized. The personnel of the panel did not vary and when a member was unavoidably absent, an estimate of his score was made from the known correlation of each member's score with the panel mean. This allowed for any small permanent variations in the tasters' interpretation of the scoring system.

RESULTS

Bacteriological Examination

In trial 1 the bacterial contamination of the carcasses on transfer from the slaughter-floor to the chiller amounted to a little over 10,000 organisms per sq. cm. on both the neck and the aitchbone area. About one per cent. of these were psychrophilic organisms and the proportion of these appeared to be greater on the neck than on the aitchbone area. These figures indicate that a satisfactory standard of hygiene was maintained during slaughter. During cooling there was a fourfold increase in the total organisms, but there was a slight decrease of psychrophilic organisms on the aitchbone area and about a fourfold increase on the neck.

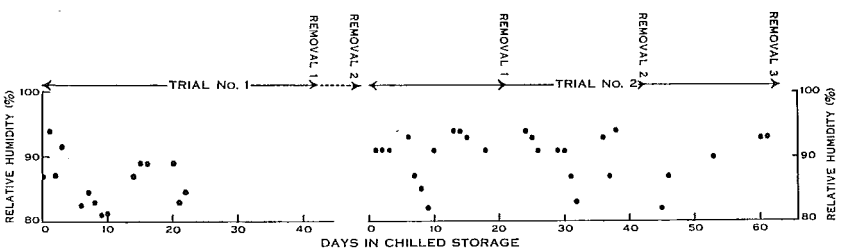
No data on contamination at the completion of slaughter were available from the second trial, but the figures for the end of the cooling period showed that at this stage the numbers of psychrophilic organisms were of the same order as in the first trial, while the total organisms were rather lower.

in the table below. The increased growth rate in trial 2 is probably significant, and a consequence of the higher temperature and humidity. The mean rates of growth of yeasts were much the same in the two trials corresponding to about a 400-fold increase in 42 days.

Growth of Organisms on Chilled Meat

	Trial 1	Trial 2
Factor by which bacterial count increased over 42 days' storage	1550	16400
Mean temperature of air (°F)	30.4	31.1
Mean humidity of air (%)	86	90

The above results for bacterial development may be compared roughly with the results obtained in the recent experimental shipment of chilled beef from Brisbane to England by S.S. *Jason*, in which it is estimated a 6300-fold increase would have taken place by the end of a storage period of 42 days. In this shipment the mean air temperature was 29.3°F; humidity was not measured.



Daily record of relative humidity of the air during chilled storage.

In both trials the number of organisms appeared to be fairly constant during frozen storage, but the low counts made it difficult to come to any definite conclusion on the fate of the organisms during frozen storage.

During chilled storage, the mesophilic organisms became an insignificant proportion of the total count before the first removal of the quarters (after 21 days' storage). In trial 1, growth of both bacteria and yeasts was somewhat more rapid on the neck than on the aitchbone but this was not evident in trial 2. If the figures are averaged and reduced to the equivalent of 42 days' storage for both trials, the bacterial growth may be summarized as

Weight Losses

The weight losses during trial 2 were very steady throughout the storage period. Large variations were evident between carcasses; these, however, were associated not with carcass weight but presumably with fat coverage. When results for both trials are expressed as percentage loss in 42 days the figures are as in the following table, which includes also data from the *Jason* and *Dominion Monarch* shipments (the latter from New Zealand to England). Weight-loss data were not obtained on the frozen quarters. The slightly higher average weight loss in trial 1 is in accord with the relative humidity and with the decreased rate of microbial development.

Percentage Loss in Carcass Weight in 42 Days

	Trial 1	Trial 2	S.S. *Jason*	M.V. *Dominion Monarch*
Crops	6.2	3.3	2.8	1.1
Hinds	2.5	2.7	2.3	1.0

Appearance

The appearance of the quarters was similar at comparable times in the two trials. Throughout storage, the thawed quarters showed good colour on the outer fat and the inner surfaces of the ribs showed a natural yellow with red flecks. In most thawed quarters the original cut surfaces were in good condition, except for some necks which were dark and a few rib ends which were rather dried out.

At the end of three weeks, there was definite bleaching of the outer fat on the chilled meat but little or no greying. There was also some darkening of the lean under thin fat coverage and on areas unprotected by fat. At this stage the original cut muscle surfaces were grey-brown and slightly moist, giving an unattractive appearance. With progress of storage the cut areas dried out and were not so unattractive, but the external fat became somewhat grey and darkening progressed on unprotected lean. Connective tissue on the shank and backbone tended to dry out and become translucent on the chilled samples. In the first trial it was noted that the spinal furrow was much more normal in appearance on the chilled than on the thawed quarters.

The colour of the lean surfaces of the butchers' cuts which had been exposed for 24 hours was almost invariably paler on the chilled sample than on its frozen pair, and in the first trial this was frequently noticeable when the quarters were being broken up on the saw. The general impression was that the stored chilled samples were paler than fresh chilled meat, and the frozen not very different from the fresh. The differences in colour of the lean are not of a nature to make any difference in acceptability, except in so far as they may be used as a criterion of the method of storage.

Colour Measurements

Attempts were made to follow colour changes in both lean and fat by means of a spectroreflectometer giving percentage reflectances of the standard C.I.E.* trichromatic colours.

In trial 1 the reflectance of the fat was significantly higher in the bleached chilled samples and there was evidence of a decrease in saturation and a shift from red to yellow. In trial 2 no significant differences were found. With freshly cut surfaces of lean there was no significant difference in reflectance in either trial, but in trial 1 there was evidence that the red colour was rather more saturated in the chilled samples.

Loss of Weight in Frozen and Chilled Carcasses of Beef during Various Periods of Storage

	Wt. Loss in Carcasses (oz/100 lb wt.)	
	Frozen	Chilled
Trial 1		
42-49 days	20.2	8.2
Trial 2		
21 days	9.0	1.4
42 days	16.5	8.4
63 days	16.6	4.1

Drip from Butchers' Cuts

The change in weight of butchers' cuts over 24 hours is due to losses from drip and to losses or gains from evaporation or condensation. In these tests it has not been possible to separate the two factors, and it is to be expected that the evaporation and condensation effects will vary considerably from removal to removal as they depend on the atmospheric humidity. However, the results from trial 2 showed that although there was a significant difference between the mean results for the three removals, the relative figures for the different cuts were consistent.

The extent of the losses can best be summarized by converting them to a carcass

*Colour can be specified in a three-dimensional system, e.g. by three suitable primary colours. The Commission Internationale d'Eclairage (C.I.E.), or International Committee on Illumination (I.C.I.), has defined by means of spectral curves three standard colours which can be mixed in suitable proportions to match visually any colour. The trichromatic coordinates of the latter may then be calculated from the amounts of the standard colours used. See, for instance, "Colorimetry", by Deane B. Judd (U.S. Bur. Stand. Circ. No. 478 (1950)).

average and expressing the losses as ounces per 100 pounds of carcass weight. The results are set out in the table on the previous page.

Off-flavours of Fat

In trial 1 peroxide values were measured on the fat of the round. No differences were found between chilled and thawed quarters, and the values were all too low to expect off-flavours to be readily noticeable. In trial 2 fat samples were taken at the second removal and cooked and tasted without any trimming. Inspection of the results showed that most of the tasters found few off-flavours or odours, and the panel as a whole could not detect any consistent differences. It is to be noted, however, that two or three tasters found strong off-flavours in some samples, and these tasters agreed in finding the strongest off-flavours among the chilled samples.

Loss on Cooking

Overall losses from preparation to completion of cooking were determined for the roasts. No statistically significant differences were noted between chilled and frozen samples.

Palatability

Each member of the tasting panel scored the cooked lean for off-flavours and odours; strength of typical meat flavour and odour; tenderness, juiciness, and colour; and general acceptability. In assessing tenderness, for instance, the following scores were used:

Very tender	8
Tender	6
Slightly tough	4
Tough	2
Very tough	0

Practically no off-flavours or off-odours were detected in the lean of either the chilled or frozen samples.

There were no statistically significant differences in the palatability scores between the chilled and frozen samples except in tenderness — the chilled lean was slightly more tender than the frozen in both trials. The differences were not important, amounting only to 0.35 and 0.43 of a unit in trial 1 and trial 2 respectively.

There were no differences in the colour of the cooked, chilled, and frozen lean, despite the previous differences in the appearance of the uncooked samples.

CONCLUSION

When similar carcasses are held in storage for the same time, both as frozen quarters at 8-10°F and as chilled quarters at 31°F and 86-90 per cent. relative humidity, the chilled material steadily deteriorates in appearance owing to bleaching and greying of the fat and to darkening of lean tissue unprotected by fat. Thawed frozen quarters, on the other hand, change little in appearance except on the cut surfaces. Over periods likely to obtain in export of chilled beef to the United Kingdom, the deterioration in appearance of the chilled product is sufficient to make it less attractive than the frozen beef.

When the quarters are broken up into butchers' cuts the exposed surfaces of lean are lighter in colour on the chilled quarters, particularly when the quarters have been exposed for 24 hours. Neither colour is unattractive. The difference in colour of the lean is not noticeable when the meat is cooked.

After breaking up into butchers' cuts the frozen material loses considerably more weight than the chilled, and the difference in loss may amount to some 4 lb per carcass. This comparison, however, does not take into consideration losses during preparation, storage, and thawing.

Carefully controlled palatability tests have failed to show any difference in odour, flavour, juiciness, colour, or general acceptability of roasts and grills from the chilled and frozen material. A small but significant difference in tenderness has been established in favour of the chilled material. It is to be noted, however, that differences in tenderness could presumably be offset by suitably tenderizing the frozen product after thawing out.

Thus, it appears from the present data that for short-term storage the only important point in favour of chilled beef lies in its small amount of "drip". If the tendency for frozen beef to drip excessively could be prevented there would be little, if any, difference in favour of the chilled meat.

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ANON. (1952).—Shipment of chilled beef. Pt. II. Rep. Dom. Lab. N.Z. No. DL 160/1/4.

EMPEY, W. A. (1930).—Freezing and chilling of prime young beef. *J. Coun. Sci. Industr. Res. Aust.* **3**: 35.

MORAN, T., and SMITH, E. C. (1929).—Postmortem changes in animal tissues — the conditioning or ripening of beef. Fd. Invest. Bd., Lond. Spec. Rep. No. 36: 60.

A New Dip for

Investigations on a new method of controlling wastage of oranges due to green mould have been carried out at the Citrus Wastage Research Laboratory controlled by the C.S.I.R.O. Division of Food Preservation and Transport and the N.S.W. Department of Agriculture at Gosford, N.S.W.

THE RESULTS OF THESE INVESTIGATIONS* HAVE been so promising that it is considered worth while issuing recommendations on how to use the method.

The chemical which has proved so potent a fungicide against green mould (*Penicillium digitatum*) is sodium orthophenylphenate, which is soluble in water, possesses a slight but not unpleasant odour, and does not corrode wood or metal.

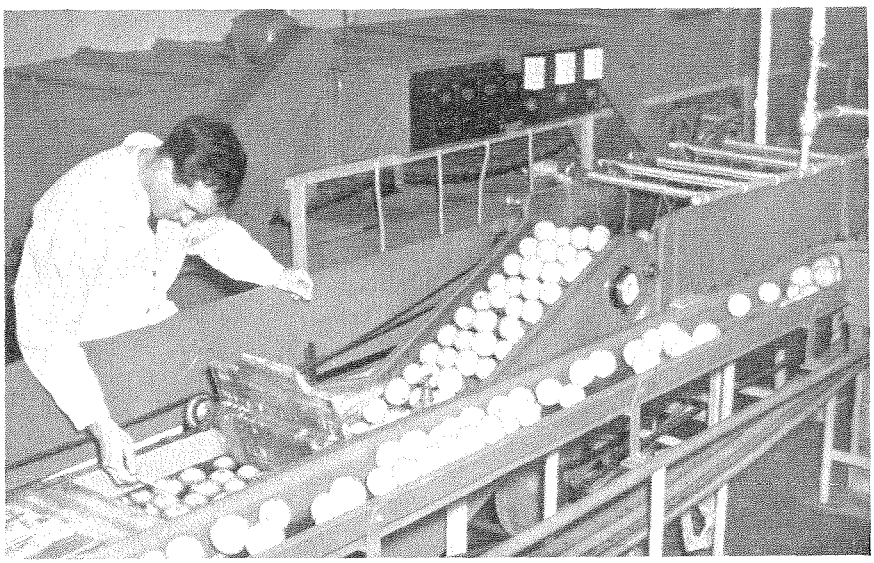
In a commercial trial at Gosford on 20,000 cases of oranges, the estimated cost of the treatment per case was only nine-tenths of a penny, which is cheaper than dipping in solutions containing borax, boric acid, and wax as recommended by Hall and Long (1950). Other advantages of the new process are:

- It is more effective than the borax dip.
- If the fruit is rinsed by means of sprays, only one tank is needed — for dipping.
- The dip need not be changed frequently.
- After being used as a dip, the sodium orthophenylphenate solution is suitable for disinfecting the packing shed, sterilizing machinery and field cases, and washing down walls, floors, and so on; the effect of the applications lasts for some time.

RIND INJURY

The chief disadvantage of the treatment is that the skin of some fruits, especially early Navel oranges, is burned by the sodium orthophenylphenate solution as shown in the illustration

*Also published in *Agric. Gaz. N.S.W.* **65**: 394-5, 412-13 (1954).



Checking the temperature of the dip at the Citrus Wastage Research Laboratory, Gosford. (The temperature should not exceed 90°F.) The fruit is conveyed from the dip tank under water sprays (on right), into a washing tank, and then through the drier (in background). (Photo.: N.S.W. Department of Agriculture.)

Green Mould in Oranges

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on page 70. Recent investigations have shown, however, that this danger can be overcome by controlling the alkalinity of the solution. The method has been tested so far only on fruit from the central coast of New South Wales but it is expected that it will be satisfactory for other areas, as similar treatments have been used in the U.S.A.

At one stage in the investigations the sodium orthophenylphenate solution was allowed to dry on the fruit, but this resulted in more skin burn, increased shrivelling, and consequently a reduction in the attractiveness of the fruit. By rinsing off the sodium orthophenylphenate, these defects are overcome without appreciable effect on mould control.

WASTAGE CONTROL

Very effective control of green mould wastage has been obtained by the use of the new dip in both commercial and laboratory trials. In practice, however, the degree of control will depend greatly on the condition of the fruit at the time of dipping. The presence of injuries due to bad handling, fruit-fly stings, and the like will increase wastage even in treated fruit. It is well known, too, that an increase in the interval between injury (and consequent infection) and the time of application of a fungicide will decrease the degree of control. It is clear, therefore, that satisfactory results can be assured only if fruit is free from marked injury and is treated as soon as possible after picking.

To apply the recommended procedure in a packing house, the fungicidal solution is incorporated in the first (or washing) tank. It is subsequently removed from the fruit either by water sprays or by passing the fruit through a second tank containing water and, if necessary, a detergent. The fruit is then passed through a drier before being graded and packed. To avoid injury to the fruit rind, the alkalinity of the fungicidal tank must be controlled by the addition of sodium hydroxide (caustic soda). Commonly used alkaline detergents, such as "M.1" and "M.3", may also be included in the first tank, the temperature in which should not exceed 90°F. The fruit should be in contact with the fungicidal mixture for two minutes, but no longer. If a power blackout or machinery breakdown occurs, the fruit in the dipping tank should be removed immediately, rinsed, and dried.

MAKING THE SOLUTION

To make 10 gal solution dissolve 2 lb commercial sodium orthophenylphenate (containing about 73 per cent. of the pure salt) in hot water. Dissolve 0.1 lb commercial caustic soda in cold water, stirring gently and avoiding splashing. When both compounds are completely dissolved, pour the solutions into the tank, which should be partly filled with water, add water to make up 10 gal, and mix thoroughly. Check the alkalinity of the mixture as explained below and add more caustic soda if necessary.

Warning.—Both sodium orthophenylphenate and caustic soda can burn the skin on contact: this should be guarded against by wearing rubber gloves, and splashing of the solution should be avoided. Repeated contact with sodium orthophenylphenate may cause a drying of the skin similar to that caused by cement. Both compounds should be stored in air-tight containers as the changes resulting from contact with air make them more likely to injure the rind of the fruit.

ESTIMATION OF ALKALINITY

Alkalinity is generally measured on a scale called the pH scale, which ranges from 0 to 14. A pH value of 14 represents maximum alkalinity, and a lesser pH value lower alkalinity. Estimations may be carried out quite readily by means of pH indicator papers which, on dipping in a solution, develop a particular colour depending on the pH value of the solution. The test paper should be

dipped into the solution and the colour produced on the paper matched *immediately* with a colour on the standard chart supplied with the papers. Merck's special indicator papers, with a pH range from 9.5 to 13.0 have been found satisfactory.

Values for pH ranging from 11.7 to 12.0 have proved quite suitable for Gosford fruit, but a value of less than 11.7 increases the possibility of rind injury. If the pH value of the dip is found to be less than 11.7, caustic soda should be added and the pH level rechecked. If the dip is to be used at 90°F, the pH estimation must be made at 90°F.

MAINTAINING ALKALINITY

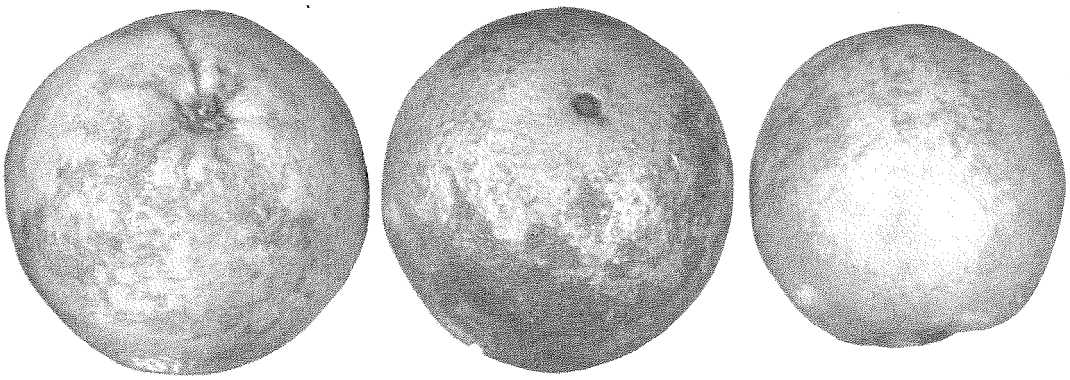
The two main factors which reduce the alkalinity of the solution appear to be exposure to air and contact with fruit, that is, with the fruit passing through the solution. Thus the alkalinity of the solution will drop even on standing, and the rate of fall will increase in accordance with the quantity of fruit passing through.

The amount of caustic soda that is needed to maintain the alkalinity of the solution will vary from shed to shed, and until experience has been gained by individual sheds, the alkalinity will need to be checked either daily or after every 1000 cases of fruit, whichever is the more frequent. When the pH value has fallen below 11.7, the addition of about 1 lb of caustic soda for every 100 gal of solution will probably be found adequate to increase the pH to the required level. When adding caustic soda to the tank, it is first dissolved in a bucketful of the original tank solution, poured back into the tank, and mixed in thoroughly.

It cannot be emphasized too strongly that pH is the only reliable indicator as to whether the solution will cause rind injury.

MAINTAINING LEVEL OF SOLUTION

The level of solution in the dip tank will, of course, fall as some of it is removed by the fruit. The amount removed will probably be of the order of 30-35 gal per 1000 cases of fruit, and this should be replaced from time to time by adding a solution made by dissolving 2 lb sodium orthophenylphenate and 0.1 lb caustic soda in 10 gal water. After the fresh solution has been added the pH should be checked.



Rind injury on early Navel oranges due to faulty control of alkalinity in the sodium orthophenylphenate dip.

CHANGING THE SOLUTION

In the commercial-scale trial at Gosford, 20,000 cases of fruit were treated in a tank containing 300 gal of dip before it was found necessary to drain, clean, and refill. Thus, to find the amount of fruit which may be treated without replacing the solution, multiply the tank capacity (gal) by 60. For example a tank containing 100 gal of solution should be capable of treating 6000 cases.

REFERENCE

HALL, E. G., and LONG, J. K. (1950).—Citrus wastage investigations at the Gosford Citrus Processing Laboratory. *Food Pres. Quart.* **10**: 48-54. (Also published in *Agric. Gaz. N.S.W.* **51**: 631-5, 662 (1950).)

Seaweed as a Food

By A. S. F. Ash

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SEAWEEDS ARE MARINE REPRESENTATIVES OF the algae, a group of simple plants which includes the microscopic diatoms and many small fresh-water organisms such as *Chlamydomonas* and *Chlorella*. Like other plants the seaweeds contain chlorophyll and require sunlight, carbon dioxide, and minerals. They are commonly anchored to rock by a sucker-like disk, the holdfast, from which may arise a branched stipe (stalk) carrying the fronds.

There are no roots, nutrients being absorbed through the fronds. A common classification is according to colour: brown, red, green, and blue-green. Only the more prolific brown and red seaweeds, in which the colour of the chlorophyll is masked by that of other pigments, are economic possibilities as foods.

Seaweed is mentioned in early Oriental and Roman texts and through the ages has been used as food and medicine in China and Japan. In the coastal areas of Europe, seaweed has long been used as a manure and for cattle food, but only to a very limited extent as human food. In South Wales, however, "laverbread", made from *Porphyra laciniata*, is a familiar comestible.

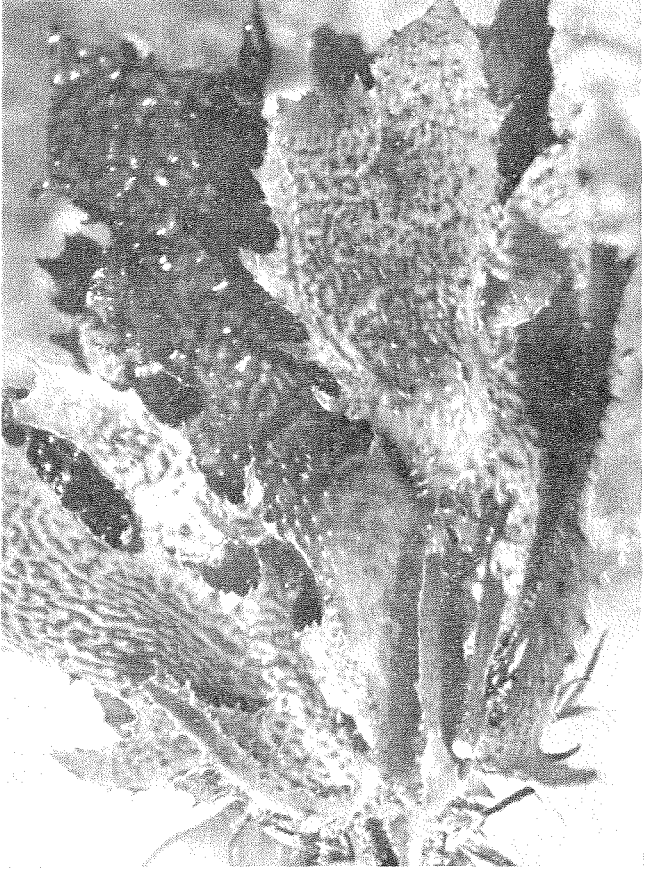
Seaweeds resemble land plants in being predominantly carbohydrate in composition. In the brown algae, e.g. *Laminaria*, the carbohydrates are chiefly mannitol, laminarin, and the cell-wall substances alginic acid, cellulose, and fucoidin (see table opposite). There are virtually no free reducing sugars. D-Mannitol, a hexahydric alcohol, is considered to be the primary product of photosynthesis. It has half the sweetness of cane sugar but can be utilized in the body only to a limited extent. Mannitol is used on some edible products as a dusting powder. Laminarin, the reserve carbohydrate analogous to starch, is composed of chains of about 20 D-glucopyranose units. It is found in the fronds and reaches a maximum before the new season's growth commences. A potential source of glucose, laminarin is well utilized by farm animals (Woodward 1951; Black 1953). Common cellulose occurs in the cell wall but the chief structural substance in the brown algae is alginic acid, a polymer of 1→4-β-D-mannuronic acid. The nutritive value of alginic acid still appears to be doubtful. Alginates are used in foodstuffs to improve texture and as emulsifying agents and are being employed in many industries on an increasing scale. The cell-wall constituent fucoidin, a polysaccharide sulphate ester of L-fucose, is probably of no value as a food.

Seasonal Extremes in the Carbohydrate Composition of Two Common Brown Seaweeds

Carbohydrate	Sublittoral Seaweed *Laminaria cloustoni* (Frond) * (% of dry wt.)	Littoral Seaweed *Ascophyllum nodosum* (Whole Plant) * (% of dry wt.)
D-Mannitol	5 - 27	6 - 12
Laminarin	0 - 36	2 - 7
Alginic acid	11 - 24	24 - 28
Cellulose	4 - 5	2 - 3
Fucoidin (March 1946)	4	7

* Data after Black (1948*a*, 1948*b*) and Woodward (1951).

Carbohydrates of the red algae, with the exception of agar, have been less extensively studied. Agar, important because of its use in bacteriological media, is found in algae of the subclass Florideae. It is a gelatinous cell-wall substance consisting essentially of 1→3-D-galactopyranose units esterified with sulphuric acid. Agar may be used as a stiffener in making confectionery and bread. It is also employed as an embedding jelly in a variety of canned foods, which it protects from metal contamination, and in the transport of cooked fish (Irving 1953). Agar probably has no nutritive value but it is an excellent laxative. Certain red seaweeds such as *Chondrus cris-*



The brown seaweed Ecklonia radiata, *a common Australian representative of the Laminariales.* (Photo: Miss Isobel Bennett.)

pus and *Gigartina stellata* contain carrageheenin ("Irish moss"). This can be used as a substitute for agar, being similar in composition. The polysaccharides of seaweeds have recently been reviewed by Mori (1953).

The protein of seaweed, as of other plants, is less easily assimilated than animal protein. Feeding tests on rats showed that the protein of brown algae (seasonal variation 5-15 per cent. dry weight) had a low biological value (Bender *et al.* 1953). In any case, these authors conclude that if brown algae can be fed only to the extent of 10-20 per cent. of the diet (Black 1953), the protein contribution is negligible. The red seaweed *Rhodymenia palmata*, which had a relatively high protein content (23.5 per cent. dry weight), was better utilized by the rats but would be difficult to harvest separately. Coulson (1953*a*) found all the essential amino acids in hydrolysates of algal proteins. Histidine was present only in trace amounts but was not the limiting factor in the feeding experiments.

Appreciable quantities of free amino acids occur in *Laminaria cloustoni* and *Rhodymenia palmata* but, in general, the non-protein nitrogen of seaweeds is chiefly peptide (Channing and Young 1953; Coulson 1953*b*).

The fats of seaweeds are of little practical importance. However, the sterol fucosterol, which occurs chiefly in the brown algae, can be converted into cholesterol (Hey, Honeyman, and Peal 1950) and is of potential value to the pharmaceutical industry.

Seaweeds are a valuable source of minerals and vitamins. All the elements required for nutrition are represented (cf. Woodward 1951). Many species have a high iodine content (0.03-1.5 per cent. dry weight), some of which is present in organic combination, probably as an iodinated tyrosine. Vitamin A appears to be absent but β-carotene, which is converted to vitamin A in the animal body, is widely distributed (Carter, Heilbron, and Lythgoe 1939). Vitamins B_1 and B_2 are known to occur (Lunde 1939) and also vitamin B_{12} (Ericson 1952; Bánhidi and Ericson 1953), which has not previously been found in plants. The concentration of B_{12} can be as high as one microgram per gram dry weight of alga. The ascorbic acid content compares well with that of green vegetables (Høygaard and Rasmussen 1939; Lunde 1939). It has been suggested that vitamin D is also present.

It can be seen that seaweeds compare favourably with land plants as sources of dietary constituents. However, they are less digestible and less palatable than the common vegetables and are unlikely to become a significant part of the diet of Western races. Oriental peoples have probably developed an intestinal flora capable of digesting the algal carbohydrates.

Seaweed is probably of greater value as a stock food (Woodward 1951; Black 1953). The minerals and vitamins are the most important contribution to the animal diet but a considerable part of the carbohydrate is also utilized. Pigs, sheep, and horses can benefit from the inclusion of seaweed meal (approximately 10-20 per cent.) in their food. Poultry-food trials have been encouraging but more than 10 per cent. of the meal upsets the mineral metabolism of the birds. Trials in Scotland (Dunlop 1953) suggested that cows find the meal rather unpalatable but when it

was accepted there was a positive response in the fat content of the milk. The use of seaweed as a stock food did not appear to affect adversely the meat and dairy products. The digestibility and nutritive value of seaweed vary in different seasons of the year but, as Black (1953) points out, this is a marked feature of most farm foods.

Seaweed is also valuable as a manure (Irving 1953), chiefly owing to its high potash content and the presence of trace metals. Although lower in nitrogen and phosphorus than typical farm manure, it has the advantage of being free from weed seeds and the spores of crop diseases. Furthermore, it improves the texture of light soil.

To make the best use of seaweed, it should be harvested efficiently at a time when the desired components are at optimum concentration. Practical means of harvesting have been designed by the Institute of Seaweed Research in Scotland (Woodward 1952). In the Pacific, the giant brown seaweed, *Macrocystis pyrifera*, should be particularly suitable for harvesting commercially. Cribb (1954) has studied its distribution in Tasmanian waters and estimated that, on the basis of three harvests per year, a minimum of 35,000-44,000 tons of air-dried weed could be obtained from the 30,000 acres of *Macrocystis* beds surveyed.

To decide the best times of the year for harvesting, one requires a study of the seasonal variation in composition (e.g. Black 1948*a*, 1948*b*, 1949). This is of the greatest importance to industries engaged in the isolation of chemicals from seaweed and is also a valuable aid to the interpretation of nutritional trials.

At a time when attention is constantly being focused on the increasing population of the world and the inadequacy of food supplies, the potential value of seaweed cannot be ignored. It is, of course, important to ensure that an increased use of seaweed and its products does not involve the plundering of resources. A percentage of the seaweed must be left after each harvest and adequate time allowed for the regeneration process.

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DRAINED WEIGHT

Earlier articles in this series appeared in the **Food Preservation Quarterly,** *Volume 31 (1953), pages 3-8 and 21-31, and Volume 14 (1954), pages 8-18, 26-31, and 46-52.*

WHEN A CANNED FOOD IS OPENED FOR EXAMINATION, the first determination made is usually that of the *net weight,* which is the gross weight of the can and contents less the weight of the dried empty can. The net weight must conform with the stated weight of contents on the label of the can.

In many packs, such as solid meat packs, pie fruits, soups, jams, and fruit juices, the net weight represents the amount of edible material in the can. But in packs in liquid media, such as vegetables in brine or fruits in syrup, the amount of usable foodstuff may be less than the net contents. Syrups from canned fruits may or may not be consumed, and brines from canned vegetables are usually discarded. With brine and syrup packs, therefore, a drained weight is determined.

DRAINED WEIGHT

By conventional procedure, originally laid down in America (cf. U.S. Food and Drug Administration 1951), drained weight is estimated by emptying the contents of the can on a circular screen of standard dimensions. For products other than tomatoes an 8-mesh wire screen (0.097 in. square openings) is specified, and for tomatoes, a 2-mesh screen (0.446 in. openings with the wire 0.054 in. diameter) (Association of Official Agricultural Chemists 1950; Royal Australian Chemical Institute 1952). For cans containing less than 3 lb the screen has a diameter of 8 in., and for larger cans, a diameter of 12 in.

Drained weight screens are preferably made from a metal which does not corrode, such as stainless steel. The screen is placed on a suitable light dish and counterpoised on a balance. The function of this dish is simply to protect the scale pan. The screen is then transferred to another dish and supported in an inclined position against the edge of the dish. The canned product is emptied on to the screen and distributed evenly without crushing. Cupped halves of peaches, apricots, etc., are placed cup downwards to permit drainage. For spinach a slightly different procedure is recommended: the can is inverted on the screen, then raised to leave the spinach in a mound. The screen is not tilted and the spinach is allowed to drain undisturbed (Townsend *et al.* 1954).

After draining for exactly two minutes the screen is returned to the dish on the balance, and the additional weight of the product is recorded as the drained weight.

SIGNIFICANCE OF DRAINED WEIGHT LIMITS

The drained weight of a canned food is determined primarily as an approximate measure of the amount of solid foodstuff that was filled into the can before processing. Canned fruits almost always give drained weights less than the fill-in weights because of osmotic shrinkage in the sugar syrup and the effects of processing on texture. Canned vegetables, however, may increase in weight when canned since the osmotic effect in the dilute brine is in the opposite direction. Hirst and Adam (1938, 1939) investigated very thoroughly factors affecting the drained weights of English canned fruits and vegetables and concluded that variety, maturity, syrup strength, processing conditions, and storage period were all significant factors.

Minimum limits for drained weight are commonly included in specifications and standards for packs in liquid media to ensure that the consumer is given reasonable fill-in weights of solid foodstuff. For some packs, it is also necessary to lay down *maximum*

Critical comments on the procedures described, and suggestions for modified or alternative methods found to be useful in practice, will be welcomed.

AND COUNT

By J. F. Kefford

Division of Food Preservation and Transport, C.S.I.R.O., Homebush, N.S.W.

drained weight limits to provide for an adequate amount of free liquid to permit heat transfer by convection. Leafy vegetables, such as cabbage, spinach, and silver beet, are most affected, since they are readily compressible after blanching and there is a risk that the fill-in weights may exceed safe limits. Thus in the Commonwealth Food Specifications (1952) for canned silver beet both maximum and minimum limits for drained weight are laid down.

Drained and Net Weights for Canned Silver Beet

Can Size	Drained Weight		Minimum Net Weight (oz)
	Minimum (oz)	Maximum (oz)	
No. 2½	19	21	28
No. 10	60	66	96

Heat processes are also specified which are bacteriologically safe only when the fill-in weight is in line with the maximum drained weight requirement. Maximum limits are not imposed for other vegetables since, in general, the fill-in weights are restricted by the nature of the products.

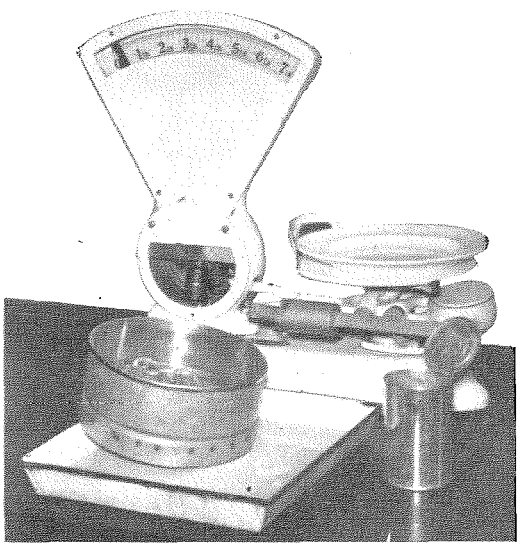
SOME RELATED PROCEDURES

After the drained weight determination, the drained solids from packs of mixed diced vegetables (Royal Australian Chemical Institute 1952) and fruit cocktail (Townsend *et al.* 1954) may be examined to determine the proportions of components. For this purpose, the drained solids are transferred to a large plate and the various individual components are separated — for example, with a rubber plate-scraper — and weighed. The weight of each component is expressed as a percentage of the total weight of all the components.

The bean content in baked-beans-in-tomato-sauce and similar packs may also be determined by making use of the 8-mesh screen. The screen with the product is held in water for a short period and gently shaken, the product is washed in running water until free of the packing medium, then drained and weighed. When composite packs, such as meat-and-vegetable ration and chili con carne, are treated in this way, it is possible to determine the proportions of the components simply by separating and weighing the individual components as described in the preceding paragraph.

COUNT

Specifications and standards for canned foods which consist of a small number of discrete



Apparatus for determination of drained weight.

units or pieces commonly prescribe limits for the *count*, i.e. the number of units in the can. For instance, the Exports (Canned Fruits) Regulations (1938) specify that canned peaches of standard quality shall contain not less than six nor more than 20 halves per can. Cans containing 6-8 halves are labelled "Large Count", 9-12 halves "Medium Large Count", 13-15 halves "Medium Count", and 16-20 halves "Small Count".

The count is determined on such packs as peaches (halves), asparagus spears, pineapple (sliced), cherries, Vienna sausages, etc., but obviously packs such as peas are not counted. Reasonable limits for the count in appropriate packs are desirable for the maintenance of standards of quality, particularly in relation to appearance and uniformity. In turn, the maintenance of standard counts depends upon satisfactory size grading of the raw products.

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NEWS from the Division of Food Preservation and Transport

WORK OF THE FISH PRESERVATION SECTION

The Fish Preservation Section has a staff of one research officer, three technical officers, and three technical assistants distributed between the Divisional Headquarters at Homebush and the two branch laboratories situated at Hobart, Tas., and Eden, N.S.W.

Fundamental investigations carried out by this Section are as follows:

- Studies of some aspects of the denaturation of the proteins of frozen fish muscle.
- The degradation of urea and trimethylamine oxide in the flesh of elasmobranch fishes during bacterial spoilage and as the result of heat processing.
- Heat inactivation of the enzyme tyrosinase, which is responsible for the development of melanin-like substances from tyrosin in certain tissues of cooked prawns.
- Development of techniques for the rapid estimation of volatile bases in fish muscle.

Applied investigations undertaken by the Section include work on a variety of fish, shell-fish, and crustacea. The problems dealt with pertain to spoilage during holding in the iced condition, and deterioration in quality of frozen and canned products during processing and subsequent storage. Experimental work aimed at improving the quality of canned fish products is carried out in the cannery of the Division's Canning Section. The Section maintains close contact with the various fish-processing industries and carries out part of its programme in commercial factories, where demonstrations of processing techniques are given when required.

PERSONAL

DR. H. S. MCKEE left Sydney on September 26, 1954, having been granted leave from the Division for two years to work for the South Pacific Commission as food technologist, with headquarters at Noumea, New Caledonia. The Commission is an international organization supported by six governments with territories in the South Pacific area, namely, Australia, Britain, France, Netherlands, New Zealand, and the United States of America. The area served by the Commission extends from Netherlands New Guinea eastwards to the Marquesas and Pitcairn Island, and includes most of the Pacific Islands north of New Zealand and south of the equator, together with a few north of the equator. The Commission is concerned with research and development throughout this wide area, with special reference to the economic and social problems of the native people.

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PUBLICATIONS BY STAFF

THE USE OF A DOUBLY-LABELLED SALT ($K^{42}Br^{82}$) IN THE STUDY OF SALT UPTAKE BY PLANT TISSUES. *R. E. Davies and Marjorie J. Wilkins. "Radioisotope Techniques." Proc. Isotope Techniques Conference, Oxford, 1951. Vol. I. (H.M.S.O.: London.)*

It has been known for several years that when well-washed storage tissues from plants are placed in a simple salt solution there is an uptake of the salt and an increase in the rate of respiration. This salt uptake normally has two components: a rapid initial uptake which is believed to be due to diffusion of the salt into the apparent free spaces of the tissue, and a slower prolonged active uptake which depends on metabolism. If metabolism is inhibited, this active uptake is also inhibited.

The experiments described were carried out to study the relation between these two components, the pH of the solution, and the rate of respiration of the tissue. An investigation was also made to determine the maximum concentration differences that could be maintained between the tissue and the cation and anion of the salt solution. A doubly-labelled salt was used in order to obtain more information about the uptake of both cations and anions. In particular, and this could be done only using isotopes, the aim was to find out if there was any "exchange" between the same ionic species inside and outside the cell.

The distribution of radioactivity in a mixture containing labelled potassium and bromide can be measured by recounting the solution after a suitable interval, but allowances may have to be made for interfering bromine isotopes with short half-lives.

By the use of doubly-labelled potassium bromide in the study of ion uptake by washed carrot disks it was shown that the leakage of ions during active accumulation is very slow, so that estimations of the *net* uptakes do in fact give the *actual* uptakes. The maximum concentration differences maintained between disks and solutions are about 800 times and could be maintained even by the energy from "low-energy" phosphate bonds. The rate-limiting factor during salt uptake by carrot disks is probably not energetic, but the supply of electrons from respiration as suggested by the work of Robertson and Wilkins on the general basis of Lundegårdh's theory.

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A DEPARTURE FROM BEER'S LAW AFFECTING THE SPECTROPHOTOMETRIC DETERMINATION OF DIPHENYL. *J. B. Davenport. Analyst* **78**: *558 (1953).*

The determination of diphenyl is of importance in the citrus fruit industry, in which diphenyl-impregnated wraps and packing containers are in widespread use. This note points out a possible source of error when the spectrophotometer is used to determine the concentration of the diphenyl.

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ISOLATION OF *l*-QUINIC ACID FROM THE PEACH FRUIT. *E. F. L. J. Anet and T. M. Reynolds. Nature* **172**: *1188-9 (1953).*

The authors describe the use of displacement chromatography on an anion-exchange resin in isolating pure *l*-quinic acid from ripe peaches, in which it is sometimes the major acid. The percentages of acids isolated from peaches from various sources are given, and the solvent mixtures used for the paper chromatography discussed.

DETERMINATION OF ETHYLENE DIBROMIDE AND ETHYLENE CHLOROBROMIDE IN AIR. *B. H. Kennett. J. Agric. Fd. Chem. 2: 691-2 (1954).*

The method has been developed for controlling the concentration of fumigant used in the destruction of the larvae and eggs of the fruit fly. The halogen compound is absorbed in ethyl alcohol from a two-litre sample of air and decomposed with sodium hydroxide, the liberated halogen being estimated by the Volhard thiocyanate method.

The procedure takes 30 minutes, and concentrations down to 1 mg per litre can be determined with a mean per cent. recovery of 99.5 ± 1.3 for ethylene dibromide and 99.4 ± 1.6 for ethylene chlorobromide.

* * *

THE OPTIMAL HARVEST TIME FOR PEA CANNING AND FREEZING CROPS IN NEW YORK STATE. I. THE DEFINITION OF OPTIMAL HARVEST TIME. II. THE SHORT TERM PREDICTION OF OPTIMAL HARVEST TIME. *R. S. Mitchell and L. J. Lynch. Food. Tech., Champaign 8: 183-6, 187-8 (1954).*

Investigations of the behaviour of crops of peas for canning were carried out during the immediate pre-harvest period by the authors over a number of seasons in Australia, and an instrument, the maturometer, was designed for the measurement and prediction of maturity. This work is described in C.S.I.R.O. Bulletins Nos. 254 (1950) and 273 (1953). Climatic conditions for the growth of pea crops in America differ so greatly from those in Australia that the New York State Agricultural Experiment Station invited Messrs. Lynch and Mitchell to demonstrate their techniques with crops grown in the Geneva area of New York State to see whether there were differences in the general behaviour pattern of the maturing peas. These papers present the results of the Geneva investigations, which were conducted during the 1953 pea season.

I. Investigations suggest that the greatest yield of first-quality freezing peas coincides with a maturometer index value of 195. This index is the reading of a representative sample of peas on the maturometer. The result for canning peas was inconclusive, but when considered in the light of previous work, a maturometer index value of 250 is probably a close approximation to the optimal harvest time. Both values were determined by an analysis of daily yields from randomized plots harvested during the last 8-10 days of the maturation period and from an analysis of records for acceptability of canned and frozen samples presented to a taste panel. Further investigation is desirable to confirm the validity of these conclusions.

II. The short-term prediction of optimal harvest time of canning and freezing pea crops is based on the ability to assess the maturity of a crop at any pre-harvest stage, a knowledge of the best time to harvest, and precise information with respect to the maturation rate. Using basic data presented in the first part of this contribution, harvest predictions were made on six crops grown at Geneva, N.Y. Results showed that the prediction method can be successfully applied to the field control of commercial pea crops.

* * *

THE KJELDAHL DETERMINATION OF NITROGEN: A CRITICAL STUDY OF DIGESTION CONDITIONS — TEMPERATURE, CATALYST, AND OXIDIZING AGENT. *H. A. McKenzie and Heather S. Wallace. Aust. J. Chem. 7: 55-70 (1954).*

There has been a widespread lack of agreement as to the optimum conditions for the Kjeldahl determination of nitrogen based on the conversion of the nitrogen in proteins and amino acids to ammonium sulphate when heated in concentrated sulphuric acid. In the present study the effect of temperature on the rate of Kjeldahl digestions in the absence of catalyst and oxidizing agent was observed.

Both the clearing time and the minimum time for complete recovery of nitrogen were markedly decreased by raising the digestion temperature. By proper choice of digestion conditions nitrogen could be completely recovered in a reasonable time even from refractory compounds. With mercury as catalyst the time was further decreased. The effects of the volume and the number of additions of hydrogen peroxide at various temperatures after different cooling times are reported. A modified micro-apparatus for the distillation of ammonia from Kjeldahl digestion is described and acidimetric methods for determining the ammonia are critically examined.

A rapid and precise method, based on these investigations, for the determination of 0.2-2 mg of nitrogen in amino acids and proteins is described.

* * *

STUDIES IN CANNING PROCESSES. I. EFFECT OF HEADSPACE ON HEAT PENETRATION IN PRODUCTS HEATING BY CONDUCTION. *H. L. Evans and P. W. Board. Food Tech., Champaign* **8**: *258-62 (1954).*

A method is given for determining the rate of heat transfer through the headspace of a can of solid food. Values of apparent heat transfer coefficients obtained for cans processed at 240°F were between 6 and 10.5 B.T.U. per sq.ft. per hr per °F. Important consequences of this low rate of heat transfer are: the slowest heating point is raised above the centre of the pack; lethal values calculated from known or assumed thermal properties of the pack are considerably lower than when headspace effects are ignored; no allowance for headspace effects is necessary when evaluating processes by measurement of temperatures but they must be taken into account when estimating equivalent processes for any cans from experimental measurements made with cans of a different shape; there is little variation in *F* values between the centre of the pack and the slowest heating point.

SOME TESTS OF ELECTROLYTIC TINPLATES IN CANS FOR AUSTRALIAN CANNED FOODS. *E. G. Davis. Aust. J. Appl. Sci.* **5**: *196-210 (1954).*

Test packs of four canned foods were held at 100°F for 15-16 months and examined for loss of vacuum, appearance of hydrogen swells, and tin and iron content. The test cans were made from electrolytic and hot-dipped tinplates of American and English origin, and lacquered internally with American, English, and Australian lacquers.

The results indicate that Australian peaches and pears can be successfully packed in cans having bodies of 1.50 lb per base box hot-dipped tinplate and ends of lacquered 0.50 lb per base box electrotinplate. For tomato juice, cans having bodies of 1.25 lb per base box electrotinplate are satisfactory. Cans for sweet corn can be made entirely from lacquered 0.50 lb per base box electrotinplate.

A flip vacuum tester and a spherometer for measuring the concavity of can ends are described.

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Copies of the papers mentioned above are available from the Librarian, Division of Food Preservation and Transport, Private Bag, P.O., Homebush, N.S.W. (Telephone: UM 8431, UM 6782.)

FOOD SCIENCE ABSTRACTS

L'INDUSTRIE DE LA BANANE A CUBA. PRODUITS A BASE DE BANANE. *(The Banana Industry in Cuba. Products with a Banana Basis.) J. J. Franco-Bétancourt. Fruits* **8**: *502-7 (1953).*

Methods of using bananas other than as fresh fruit would be useful, especially in countries without refrigeration, e.g. Cuba, where bananas *(Musa sapientum)* and plantains *(Musa paradisiaca)* are important crops. Fried plantain "chips" are already very popular. Experiments showed that sliced bananas are best fried in oil at 168-172°C for 120-150 seconds, and plantains at 173-178°C for 90-120 seconds. Plantains can be sliced more thinly, and yield a better product than bananas, and further work was carried out with plantain "chips". When stored at 50°C, these became rancid after 32-40 hours. Of various anti-oxidants tested, a mixture of propyl gallate, lecithin, maize oil, and citric acid ("Griffith G.4") gave the best results; it was added in a concentration of 0.05 per cent. to the frying oil. Drying of bananas and plantains, and processing to give a fine powder, are also practised. Development of brown colour and loss of ascorbic acid are the chief problems to be overcome. They can be largely prevented by immersion in a solution of sodium chloride, but high concentrations are required and these give a salty taste. Thiourea and allylthiourea are even more effective, but are not authorized as food additives by United States regulations.

Sodium bisulphite (0.05 per cent.) appears to be the best preservative to use. Alternatively, and especially if the banana flour is intended for infant foods, the fruit may be blanched before drying to prevent browning, and ascorbic acid may be added to replace losses. Slices of banana and plantain treated with ascorbic acid before drying develop a pink colour, attributed to a reaction between ascorbic acid and amino acids. A successful preserved banana product has been made by peeling the fruit very carefully, blanching in steam to bring the internal temperature to 75-83°C, pulping, mixing with sugar and acid to pH 4.3, heating to 90°C, and canning. Contact of the fruit with iron must be avoided. Overripe bananas may be used for the manufacture of vinegar.

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ELECTRONIC STERILIZATION OF FOODS. *R. S. Hannan. Research* ***6****: 376-83 (1953).*

A summary of the main features that have emerged so far in work on the electronic sterilization of foods. The radiations used (high-voltage cathode rays and γ-rays from radioactive materials) have the property of ionizing certain molecules of the bacterial cells and thereby destroying their power to reproduce. The logarithm of the number of surviving bacteria decreases linearly with increasing dose of radiation, but the sterilization dose for a given product depends partly on the treatment it has received and on other factors. The doses that destroy higher animals, insects and their eggs, bacteria, yeasts and moulds, bacterial spores, and viruses are, respectively, of the order of 1,000, 100,000, 500,000, 1,000,000, and 5,000,000 rep (roentgen equivalent physical). Cathode rays have the disadvantage that only thin layers of material can be sterilized; γ-rays, produced by waste products from atomic energy projects, require complicated protective measures for workers. Both tend to cause unpleasant flavours and odours and changes of colour and texture in foods. Irradiation at very low temperature in the absence of oxygen minimizes these effects. The irradiation of meat, fish, dairy products, and fruits and vegetables is discussed. The cost of the process is likely to be high, and it will probably be used first for pharmaceutical and medical purposes.

KEEPING FROZEN FOODS YOUNG. *C. F. Evers. Quick Froz. Fds.* ***16****(4): 61, 172 (1953).*

Attention is drawn to the increasing use of "Ac'cent" (pure monosodium glutamate) for enhancing the flavour of frozen foods. It has been reported that the addition of "Ac'cent" not only improved the flavour of the frozen foods tested but lengthened the storage life of many products and increased the juiciness and tenderness of others. A machine has been developed for dispensing a predetermined amount of "Ac'cent" solution and has facilitated the addition of monosodium glutamate to frozen vegetables. As a measured volume of vegetables is dropped into the empty carton, the dispensing machine releases a 2-ml spray of "Ac'cent" solution in a concentration sufficient to give 0.15 per cent. of "Ac'cent" to each filled package. When added before freezing, it penetrates to the interior of vegetables. Consumer tests have indicated a strong preference for foods packed with pure monosodium glutamate.

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YELLOW DISCOLORATION IN FROZEN LOBSTER MEAT. *W. J. Dyer and D. C. Horne. Fish. Res. Bd. Can., Atlantic Fish. Exp. Sta. Circ. (N.S.) No. 2 (1953).*

The yellow discoloration and the accompanying off-flavour that develop in stored frozen lobster flesh appear to be associated with the oxidation of the red pigment to a yellow one. The oxidation occurs especially in the tips of the claws, which have a higher fat content than the rest of the meat. Development of discoloration is rapid in the window and in open-seam push-cover types of can, neither of which should be used. The use of sealed cans, or vacuum pack cans, coupled with quick freezing and storage at low temperatures, should prevent any discoloration. Anti-oxidants such as ascorbic acid may also be effective.