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The maturometer and maturometer predictor devised by C.S.I.R.O. for measuring the maturity of peas and predicting their optimal harvest maturity for canning are well known, but C.S.I.R.O. continues to seek improvements in methods for controlling the quality of green peas for processing.

Measuring Quality

IN 1945 C.S.I.R.O. commenced an investigation on means of improving the quality of canning peas. The first step was to devise a rapid and precise method of measuring canning maturity, and the second to define and predict the optimal harvest time of peas intended for canning. The first stage culminated in the invention of the maturometer (Lynch and Mitchell 1950), and the second in the invention of the maturometer predictor (Lynch and Mitchell 1953). Current investigations on several factors which affect the measurement of pea crop maturity by the maturometer, the mechanics of operation of the maturometer and the related instrument the tenderometer, and the use of size graders and gravity separators for the quality control of green peas for processing are discussed in this article.

SAMPLING

The aim of sampling in general is to discover one or more properties characteristic of a particular population. A true picture can be obtained only by measuring every individual in the population, but for various reasons this can rarely be done. It is therefore necessary to use a selected sample of limited size. Such limitation involves error, but this must be small enough for the sampling to achieve its purpose, namely to provide a fair picture of the population from which it is drawn. Sampling for the maturometer involves following the procedure below for sampling in the field, and subdividing the vined pea sample so obtained to get samples to present to the instrument.

Sampling from the Field

The procedure laid down for field sampling is: for each 10 acres of peas or less, an area of approximately one square yard of vines should be taken at each of four points in the crop. Where the crop is reasonably uniform the four points may be equally spaced along a diagonal or, if the field is more or less rectangular, along a central line drawn in the direction of the longest dimension. The vines are bulked and passed through a cleaned viner at such a speed that most of the peas are recovered without apparent injury. Peas are collected for five minutes and those smaller than $\frac{9}{32}$ in. are removed by sieving. The sample is thoroughly mixed and the mean of four separate maturometer readings is recorded as the maturometer index (M.I.).

To test the validity of the field sampling procedure, two uniformity trials were conducted in Tasmania. The results, which were similar, may be illustrated by reference to the trial at Sheffield. An area of five to six acres, specially selected because of its apparent variability, was harvested at 36 points on three successive days. The vines from each harvest point were separately vined and the M.I. determined. When values from all 36 points were bulked, the results in Table 1 were obtained.

These figures indicate that by the use of a 36-point sample one might expect, with a 95 per cent. degree of confidence, that the M.I. value obtained was accurate to about half the daily increment of 20.

The values from the 36 points were

Table 1.—Uniformity Trial at Sheffield, Tas., 1953

Date of Harvest	M.I. Mean and Standard Error	95 Per Cent. Confidence Range	Semi-confidence Interval
Jan. 26	$182 \cdot 5 \pm 4 \cdot 5$	174·0-191·0	8·5
Jan. 27	$192 \cdot 0 \pm 5 \cdot 5$	180·5-203·5	11·5
Jan. 28	$221 \cdot 0 \pm 6 \cdot 5$	208·0-234·0	13·0

By R. S. Mitchell and L. J. Lynch
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in Green Peas

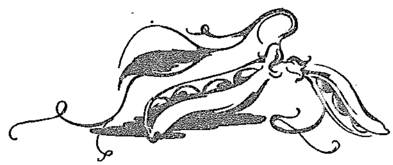

Table 2.—Uniformity Trial at Sheffield, Tas., 1953
Ninety-five per cent. semi-confidence intervals of maturometer indices for 4-, 6-, and 36-point samples

Date of Harvest	4-Point Sample	6-Point Sample	36-Point Sample
Jan. 26	36·5	18·5	8·5
Jan. 27	41·0	26·5	11·5
Jan. 28	57·0	30·5	13·0
3-Day mean	18·5	13·0	—

grouped into a series of four- and six-point samples with the results shown in Table 2.

It is important to note in Table 2 the rise in the semi-confidence interval with reduction of sample size; in fact the error from a single-day four-point determination is too large to provide a fair picture of the population. The effect of the three-day mean value, however, is to increase the sample size, and the error in this case is reduced to a level where any particular value is within one day of the true maturity of the field. This error is within the limits of the precision required for harvest, since a satisfactory result will be achieved if the crop is harvested within 24 hours of reaching the desired maturity (M.I. 250), that is in the M.I. range 230–270. It may therefore be concluded that any reduction below the four-point three-day-mean sample size would result in too great a margin of error. On the other hand the use of samples from six or more points is likely to make an excessive demand on labour resources.

Sampling for the Maturometer

A number of criticisms have been made of the excessive variation in readings obtained in the course of quadruplicate determinations of M.I. by the maturometer. The sample must, of course, be mixed thoroughly, the recommended procedure being to lift a handful of peas and allow them to trickle through the outspread fingers. Nevertheless, variations still occur and, as demonstrated in Table 3, these become greater as the maturity of the sample increases.

It may be stated categorically that reading-to-reading variation is not due to instrument error but to the variability in maturity inherent in green peas. In other words, the instrument merely records the maturity of a sample plate of peas at any one operation. While the difference between one reading and the next may be reduced by careful attention to mixing, it can never be eliminated because the number of peas on a plate (143) is not sufficient to contain the maturity variations in the proportions in which they occur in the original sample. The quadruplicate procedure, which is based on the statistical examination of the data for 10 seasons, is recommended because it increases the effective size of the sample. It is not possible to present these data here, but the measure of crop control obtained with the maturometer is a practical demonstration that the method of using it is sound.

A practical point worthy of note in connexion with sampling for the maturometer is that any attempt to mix the sample by

Table 3.—Trial at Moltema, Tas., 1955
Mean range in quadruplicate readings of maturometer index with increase in sample maturity

Date of Harvest	M.I. of Sample	Mean Range
Jan. 7	77	9·5
Jan. 9	93	13·0
Jan. 11	118	15·5
Jan. 15	176	26·2
Jan. 18	259	43·3

shaking will result in segregation of the peas on a size and hence on a maturity basis. This fact has been amply demonstrated by Professor Frank Lee of the New York Agricultural Experiment Station. Lee (1939) made tenderometer readings on samples obtained by dipping a can into lug-boxes of peas which had been delivered to a factory. He compared these with a determination on a composite sample made up from seven or eight lug-boxes, the contents of which had been thoroughly mixed. Thirty-three sets of figures were obtained in this way. In five cases the readings were higher for the can-dipped samples, in six cases they were identical, but the remaining 22 observations showed higher readings for the carefully mixed samples. The explanation is that vibration during transport causes the larger and older peas to collect at the bottom of the box, so that peas removed from the top gave a lower reading than the average value obtained after careful mixing.

Comparisons have been made (Lynch and Mitchell 1950) of reading-to-reading variation in comparable samples of peas presented to the maturometer and tenderometer, and it has been concluded that there is considerably less variation in the tenderometer. It is not possible, however, to make a true comparison of the two instruments in this way, for allowance must be made for the scale magnitude of each instrument and the difference in the size of sample presented to each. A scale of 500 on the maturometer is to be compared with one of 200 on the tenderometer, and the sample tested by the tenderometer is three times as large as that tested by the maturometer.

Finally, attention should be drawn to what might be described as presumptive evidence of the validity of the whole sampling procedure recommended for the control of crop maturity. The maturometer index is determined on an ungraded sample of peas, and if it is a true reflection of maturity the value obtained should depend on the individual maturities of each of the size grades and the numbers in which they occur in the sample. To test this point, portion of the ungraded sample has been submitted on many occasions for direct M.I. determination, and the remainder has been subdivided into size grades which also have been tested by the maturometer, after the number of peas in each grade has been calculated from their total weight and the weight of 100 peas. In this way it has been possible to derive a weighted mean value termed the calculated M.I. for comparison with the measured M.I. Table 4 quotes values from one of the many comparisons made in this manner.

Table 4.—Trial at Moltema, Tas., **1955**
Comparison of calculated and measured maturometer index

Date of Harvest	Maturometer Index	
	Calculated	Measured
Jan. 7	83	78
Jan. 8	79	81
Jan. 9	88	90
Jan. 10	102	108
Jan. 11	115	119
Jan. 12	121	123
Jan. 13	140	139
Jan. 14	156	155
Jan. 15	166	178
Jan. 16	187	202
Jan. 17	212	212
Jan. 18	252	246

Taking into consideration manipulative errors and errors of sampling the agreement between these sets of values is remarkably good. Such a consistent result, involving 12 consecutive days and over 70 separate maturometer determinations, could not be obtained if the samples were inadequate.

MATUROMETER AND TENDEROMETER

Throughout the C.S.I.R.O. pea processing investigations a consistent relationship has been found between maturometer and tenderometer readings. The relationship has been expressed as a coefficient of correlation, and by regression equations which permit the values determined on one instrument to be predicted from values obtained on the other. Despite the close relationship that has been exhibited the results obtained, together with other observations, suggest that the two instruments are not measuring the same physical quality in peas. An investigation was therefore conducted into the mechanism of measurement by each instrument.

The maximum reading on the maturometer was found to occur when the pins are a fraction above or below the top surface of the sample plate, the exact position depending on the average size of the peas in the sample. At the point of maximum reading all peas irrespective of size have been penetrated, and therefore every pea in the sample makes a contribution to the final reading. Careful observation of the maturometer in operation will frequently disclose a brief hesitation in the progress of the pointer as it passes over the dial of the recording gauge. This hesitation coincides with a break-through of the pins into the space between the cotyledons, and has been found to occur in peas approaching optimal harvest time but not in very young peas. The final reading is recorded when the pressure developed is sufficient to overcome the residual resistance of the incompletely penetrated sample, at which time the pointer on the dial falls away sharply, leaving the indicating pointer at maximum registration. The maximum reading occurs shortly after the pins enter the lower cotyledon. The maturometer therefore appears to measure directly the texture or hardness of the pea cotyledon plus the tensile strength of the lower portion of the skin.

The tenderometer is reputed to measure the force required to shear a sample of peas through a standard grid. The maximum reading was found to occur immediately after the two sets of grids meshed, but before this point is reached all peas in the sample have been disintegrated. The mashed pea is forced between the apertures of the grids, and as with the maturometer, the movement of the pointer across the scale is momentarily halted as the maximum reading is approached. This retardation occurs when pea material commences to extrude above the upper grid. The pointer then continues along the scale until the mashed material issues beneath the lower grid, when the maximum reading is obtained. The tenderometer, therefore, does not measure the force required to shear the sample, but that required to push the mashed material through the constricted areas between the grids. This explains why tenderometer measurements are not affected by variations in viner speed. On the other hand, since cotyledon texture and the integrity of the skin are altered during vining, maturometer readings will reflect the speed of the viner operation.

The conclusion from the work is that while the instruments measure different physical qualities in a sample of peas, both measures are valid since they show high correlation with the alcohol-insoluble solids content and with each other.

VINER OPERATION

A series of experiments have been conducted in the United States of America and Australia to assess the influence of viner speed on the degree of tenderization of peas. In the American work (Moyer, Lynch, and Mitchell 1954) one commercial and one experimental viner were used and three pea varieties were involved. The amount of pea injury was shown to be directly proportional to viner speed and independent of variety and maturity. The Australian investigations included two additional varieties, and a commercial viner was used. The local work was more detailed in that a greater number of speeds was selected, and more samples were treated. The following regression equation enables an estimate to be made, on the basis of maturometer readings, of the tenderizing effect of viner speed:

$$\text{M.I.} = \text{M.I.}_0 - 0{\cdot}57\ S,$$

where

M.I. = maturometer index of viner sample,
M.I._0 = maturometer index before vining,
S = viner speed (r.p.m.).

Example: if a sample when carefully hand-shelled is found to have a maturometer index of 350, then the same sample vined at 165 r.p.m. would have a maturometer index of 256.

The Australian work gave some evidence of a maturity effect but the above equation is a reasonable approximation for peas having a maturometer index in the range 150–300. The yield at various viner speeds was also investigated, and optimal recovery was obtained in the range 165–180 r.p.m. There was a highly significant drop in yield approaching 150 and 200 r.p.m. At the lower speed the drop was due to incomplete removal of peas from the pod, and at the higher speed to fragmentation of some of the peas.

In the viner investigations, replicate samples of 60 pounds of vines were used, but it would not be possible to feed a viner continuously with such a quantity of vines under commercial conditions.

Observations on commercial viners, however, have shown similar results at a number of speeds, though it has not been possible to assess relative performance on a quantitative basis.

QUALITY GRADING

In recent years there has been a marked trend away from the size-graded pack, which previously served the dual purpose of quality control and eye appeal. The ungraded pack has much to commend it from the point of view of economy of operation, and it was therefore felt that some precise knowledge of the efficiency of the gravity separator should be obtained.

Specific gravity and maturometer index determinations were made on a large number of ungraded samples, which were subsequently size-graded and the determinations repeated. Individual peas of each size grade were blanched and placed in a cylinder of water, and rate of fall was determined by measuring the time taken to drop through a water column $9\frac{9}{16}$ in. high.

Correlation coefficients were worked out between maturometer index and specific gravity for ungraded and graded peas:

Ungraded	Size 2	Size 3	Size 4	Size 5	Size 6
0·57	0·45	0·71	0·59	0·17	−0·12

The following correlation coefficients were also obtained:

M.I. and S.G. (eliminating size)	0·148
M.I. and size (eliminating S.G.)	0·613
S.G. and size (eliminating M.I.)	0·637

The first of these correlations is not significant and the other two are highly significant.

These results suggest that for any one crop the largest peas are the oldest or most mature, and that size is therefore an important factor in quality. Specific gravity has always been shown to be a valuable measure of maturity, but since it increases with age it cannot be readily dissociated from size. These results do not mean that peas of a particular size grade from any source are always of identical maturity, since the time taken to reach a given size depends on a large number of environmental factors. In general the peas of size grades 5 and 6 from a 5000 lb per acre crop will be no more mature than peas of size grades 4 and 5 from a 3000 lb per acre crop, because maturity is affected by time or age in addition to size.

The most important conclusion to be drawn from the above correlations is that maturity (or quality) may be defined more accurately in terms of size than of specific gravity. In view of this, further work was undertaken to test experimentally the relative influence of specific gravity and size on time of fall through water. A multiple correlation coefficient of +0·97 was obtained, and it was concluded that these two factors almost exclusively determine the rate of fall.

When time of fall was considered in relation to specific gravity alone a partial correlation coefficient of −0·59 was obtained and when the effect of specific gravity was eliminated, the correlation coefficient was −0·81. These figures suggest that size is more important than specific gravity in the separation of peas of different maturities by means of a column of water. The position is not quite the same for brine solutions, for which data are not yet available, but the facts suggest that specific gravity is not likely to provide the dominating influence until the values for peas and brine approach each other.

If these considerations are valid the final conclusion from this work is that a well-designed size-grader would probably provide a more efficient means of quality separation than the gravity separator which is now commonly employed in the pea processing industry. Further work remains to be done to clarify this important problem.

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FOOD STORAGE IN ANTARCTICA

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DURING recent years there has been considerable activity in the Antarctic regions by many nations, and several reports have appeared in the newspapers of the uncovering of food caches laid down by past expeditions. Some foodstuffs left behind by Shackleton and Scott have been described as sound and edible forty years later.

Prompted by such observations, Admiral Richard Byrd has suggested to the U.S. Government that Antarctica might serve as a gigantic refrigerator to store surplus agricultural commodities for future use in feeding a greatly expanded world population.

These reports and conjectures provide a topical background for a report on some observations on the behaviour and out-turn of a number of foodstuffs stored under Antarctic conditions.

EXPERIMENTAL CONSIGNMENT

For some time the Defence Food Research Section of the Australian Department of Trade has been interested in assessing the performance of foodstuffs under low-temperature conditions. With the cooperation of the Antarctic Division of the Department of External Affairs, a small consignment of canned foods was stored for a year in Antarctica and then returned to Australia and examined at the Division of Food Preservation and Transport, C.S.I.R.O.

The consignment consisted of two cases of representative canned foods selected partly on the basis of previous experience of the performance of canned foods at Heard and Macquarie Islands. The procurement, packing, and despatch of the items under trial were arranged by the Department of the Navy through the agency of the Naval Victualling Yard, Port Melbourne. The samples were stored at Mawson, the mainland base of the Australian National Antarctic Research Expedition, from January 1954 to February 1955, then brought back intact to Australia by the relief vessel *Kista Dan*. Temperatures recorded at Mawson during this period ranged from −21·8°F (the minimum for September) to 45°F (the maximum for December). To provide unfrozen control samples, cans from the same packs as those sent to Mawson were held at the Homebush laboratories of C.S.I.R.O. at 32°F for the same storage period. The control and Mawson samples were examined together in May 1955.

The Australian National Antarctic Research Expedition Station at Mawson, February 1956.
(*Photo: Phillip Law. Reproduced with permission of Antarctic Division, Department of External Affairs.*)

CANNED FOODS

The canned foods tested may be divided into three categories according to their quality after storage at low temperatures.

- Products virtually unaffected by storage in Antarctica for one year:

Corned beef	Butter concentrate
Pork and beef loaf	Cherries

It may reasonably be assumed that all solid meat and meat-loaf packs would come into this category.

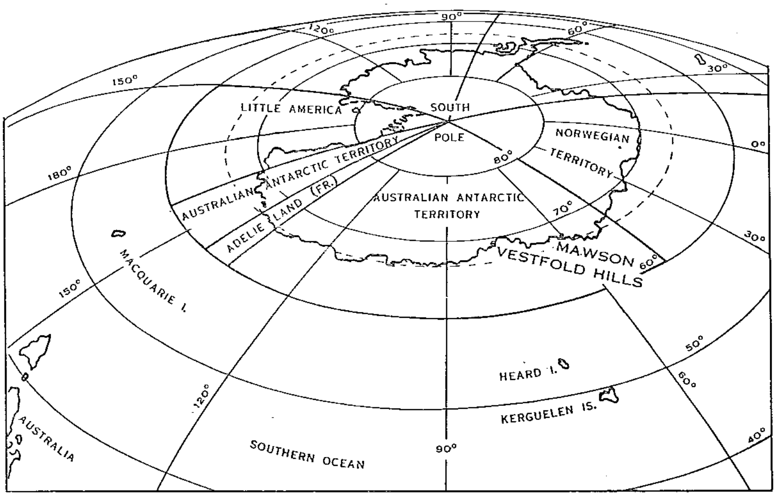
- Products which showed slight deterioration in texture or consistency but remained acceptable:

Casserole steak	Apricots
Pork sausages	Pears
Australian salmon	Fruit cocktail
Kippers	Tomato juice
Sardines	

and whey" appearance associated with a granular texture on the palate. The original consistency was restored by blending for one minute in a Waring Blendor but not by mixing with a domestic egg beater.

Canned Vegetables

In the canned vegetables from Mawson the breakdown in structure was equally striking. Cauliflower was completely disintegrated to a purée, and asparagus had lost its rigidity and crispness. Cream-style corn had a "sawdust" texture and showed excessive syneresis following breakdown of the starch gel. Potatoes and carrots appeared as spongy or cellular masses from which the liquid contents could be "wrung". Green peas remained normal in appearance, but within the skins the cotyledons had broken down to hard granules which were "sandy" on the



The Antarctic Continent, showing the Australian Stations at Mawson and Vestfold Hills. (Drawn by and reproduced with permission of Antarctic Division, Department of External Affairs.)

- Products which showed structural changes amounting to serious quality deterioration:

Meat and vegetables	Green peas
Unsweetened condensed milk	Cauliflower
	Potatoes
Reduced cream	Carrots
Asparagus	Whole tomatoes
Cream-style corn	

Milk Products

Detrimental changes in structure were most marked in the milk products. The normal smooth consistency of condensed milk and cream was changed to a "curds

palate. Less mature peas, however, are reported to retain satisfactory quality after freezing.

The nature of the quality deterioration in the badly-affected packs suggested that freezing had caused an irreversible change in the hydration of these products leading to breakdown in the colloidal structure. Water removed as ice was evidently not completely restored to the tissues or colloids on thawing so that some foods broke down completely and in others partially dehydrated material remained as hard granules. Similar phenomena have been commonly observed in the freezing of colloidal systems.

AN HISTORIC COMMENT

Captain F. M. Crozier, R.N., whose name is commemorated in a cape at the eastern end of Ross Island in the Ross Sea, Antarctica, recorded in 1839 during a voyage of discovery in the Antarctic regions that canned veal was included in the provisions aboard his ship, H.M.S. *Terror*. He added, "Our food was on the whole of fair quality, and I did relish the canned veal in iron canisters sealed up from the air. It turned out of the can as a solid block of ice and had to be stoved before use. How sweet and fresh it was, just as from the vealer at home. Other canned meats were in good condition. Only food in the can will sustain man in his geographical quest in these cold parts of the earth as it must be preserved across the hot foreign regions."

The out-turn of canned foods consumed at Mawson, as reported by the leader of the 1954 Expedition, Mr. Robert Dovers, and by the Messing Officer, was generally similar to that of the experimental samples. However, agitation on the long sea voyage after thawing evidently exaggerated the breakdown in structure in the canned vegetables examined at Homebush. Nevertheless, canned vegetables at Mawson were described by members of the expedition as mushy, and some varieties were suitable only for soup.

It is not clear why canned fruits were much less affected by low-temperature storage than canned vegetables, since the temperatures were quite low enough to freeze syrups with cut-out Brix around 20°. Jams too were found not to be adversely affected by low-temperature storage.

Glass-packed foods were not acceptable for use in Antarctica because of general fragility and liability to breakage when the contents froze. Therefore, pickles and condiments were canned and flavouring essences were packed in polythene bottles.

FRESH FOODS

The observations on the performance of canned foods in the Antarctic may be supplemented by some notes on the behaviour of fresh foods, based on the Messing Officer's reports. Butter and cheese presented no problems in quality deterioration.

Potatoes, other root vegetables, and onions kept satisfactorily for the greater part of the year while they remained frozen, but they deteriorated rapidly during the summer thaw, about the end of November. Citrus fruits kept reasonably well for a few months but apples were not a success.

Fresh meat was frozen in the glacier ice and retained satisfactory quality for about one year, the stocks being consumed before the main thaw of summer. Seal meat held over the thaw period became spoiled. Unprotected foods also suffered rapid desiccation because of the low relative humidity in the Antarctic climate.

DRIED FOODS

Under the conditions prevailing in Antarctica, dried foods should have a very long storage life and that, in fact, was the experience of the party at Mawson. Dried fish, dehydrated vegetables, egg powder, milk powder, and dried soup mixes were reported upon favourably, and ice-cream mix was particularly popular even in the land of eternal ice.

ACKNOWLEDGMENTS

The observations reported here were made possible by the ready cooperation of many parties, notably Mr. P. G. Law, Director, Antarctic Division, Department of External Affairs, Melbourne; Mr. Robert Dovers, Officer - in - Charge, Australian National Antarctic Research Expedition Station at Mawson, 1954; Mr. J. Shipton, Chief Food Technologist, Department of Trade, Sydney; and Mr. T. F. Daniel, Director of Victualling, Department of the Navy, Melbourne.

Corrigendum
Volume 16, Number 2

Page 36, second column: *The caption of the diagram should read* The titration circuit *instead of* Apparatus for coating the electrodes, *and the last two sentences should be combined to read:* The most satisfactory is to electrolyse a 5·0 per cent. solution of silver chloride in 10 M ammonium hydroxide for a few hours using a 1·5-volt dry cell with silver wires as the anode and a carbon rod as the cathode.

Results of a storage trial at 0°F of fast-frozen wrapped beef roasts and grills using several forms of wrapping material.

Quality of Pre-wrapped

THE pre-wrapped food pack, with its associated refrigerated display unit, is becoming a distinct feature of the food trade in Australia and there is evidence that it may also become an important factor in trade between Australia and the United Kingdom. Within the retail meat trade in Australia the pre-wrapped ready-to-use pack has been largely limited to unfrozen meat but there are indications of an interest in the pre-wrapped frozen pack particularly for institutional needs and for the armed services.

There is a considerable volume of literature on the techniques for preparing and handling frozen pre-wrapped meat, especially in the United States. There are also adequate data on the properties of wrapping materials available overseas. As yet, however, few of these techniques or materials have been tested under local conditions. It can be assumed that the following factors must be considered in assessing the suitability of techniques for handling frozen pre-wrapped meat:

- Appearance of wrapped frozen cuts.
- Appearance of wrapped and unwrapped thawed-out material.
- Weight losses due to evaporation during freezing and storage.
- Drip losses on thawing.
- Eating quality of the product.

Bacteriological spoilage is usually not important in frozen meat.

A trial has been carried out at the C.S.I.R.O. Meat Investigations Laboratory, Brisbane, to compare certain techniques with the above criteria in mind, and to compare pre-wrapped frozen cuts with bulk-frozen meat under comparable storage conditions.

METHOD

The trial was made with grilled rump steaks and rolled sirloin roasts. To overcome variability in material from animal to animal a balanced incomplete block design was used with blocks of two comprising similar sites on the opposite sides of a single carcass.

Six treatments were applied to both roasts and grills. In both cases the first treatment consisted of freezing and storing as quarters, breaking up into typical retail cuts at completion of storage, and then thawing as cuts. For the other five treatments the cuts were prepared from the appropriate position in the chilled quarters, then wrapped as required, weighed, and frozen in a blast freezer with an air temperature of −40°F and an air speed of 1000 ft/min.

For roasts the treatments applied were:

(1) Frozen and stored as quarters.
(2) Frozen and stored without wrapping.
(3) Wrapped in heavy wax-paper.
(4) Wrapped in polyethylene tubular wrap with the closure folded and sealed with adhesive tape.
(5) Wrapped in polyethylene tubular wrap with closure heat-sealed.
(6) Vacuum-sealed in shrinkable polyvinyl-vinylidene chloride plastic wrap.

For grills the treatments were:

(1) Frozen and stored as quarters.
(2) Frozen and stored without wrapping.
(3) Wrapped in heavy wax-paper.
(4) As for (3) but also enclosed in a cardboard box.
(5) Wrapped in heat-sealed polyethylene tubular wrap.
(6) Vacuum-sealed in shrinkable polyvinyl-vinylidene chloride plastic.

Temperatures were measured at the centres of the packaged joints during freezing. Typical cooling curves are shown on page 51, from which it is seen that only for the grills were the rates of freezing comparable with

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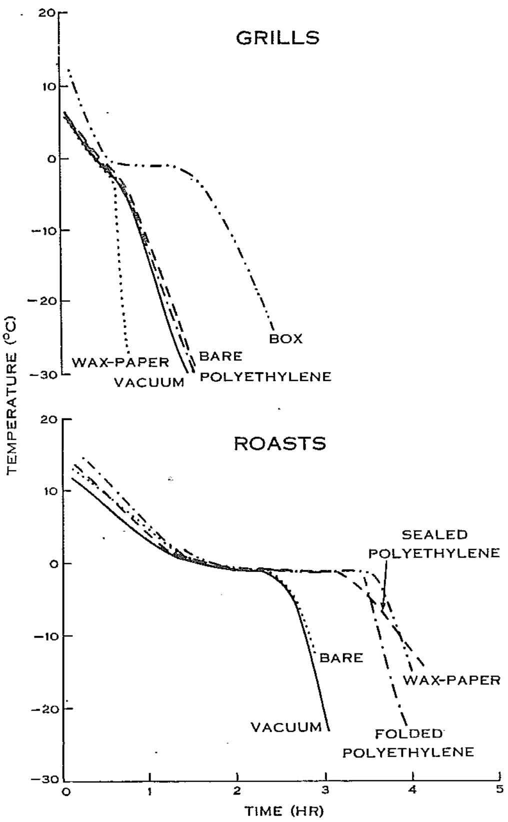
Frozen Meat Cuts

those given by Moran (1932) for rapid freezing, namely 32–48 minutes to fall through the range +5°C to −5°C. The curves show clearly the effect of the resistance to heat flow of the air gaps in wrapped roasts without vacuum sealing and of the box in treatment 4 of the grills.

On completion of freezing all samples were transferred to a store at 0°F and held there for 11–12 weeks. When put into store the samples frozen without wraps already showed freezer burn, particularly the grills.

After storage the samples were removed as required, inspected, weighed, and allowed to thaw for 24 hours. They were again inspected, weighed, then cooked and tasted. Cooking and tasting were carried out according to the procedure normally followed at the C.S.I.R.O. Meat Investigations Laboratory (Howard 1956).



Typical freezing curves for roasts and grills.

APPEARANCE

As already indicated, unwrapped roasts and grills showed considerable freezer burn on completion of freezing. The samples in transparent non-vacuum packs showed some formation of snow particularly where the wraps were loose. The appearance of the samples changed little during storage.

After thawing, the roasts were generally much more attractive than the grills, which tended to be rather dark on the under side. Of the roasts, the samples wrapped in polyethylene were generally fair to good, except where failure in the heat-seal had caused mild freezer burn. The best of these samples were very close to the bulk-frozen material. On removal from the wrap the vacuum-packed material had a dull purplish appearance on account of the reduced oxygen level, but on exposure to the air it soon assumed an attractive bright red colour. The sample wrapped in greaseproof paper showed some freezer burn and bleaching of the fat, but its appearance was generally described as fair. The unwrapped sample showed rather more bleaching and freezer burn.

Much the same observations apply to the grills. The unwrapped samples showed considerable freezer burn and their appearance ranged from a white and unnatural appearance to dull, dark, and repulsive. The samples wrapped in heavy wax-paper were dark, moist, and rather unattractive, the samples in the boxes being slightly better than those not in boxes. The appearance of the cuts wrapped in polyethylene was fairly good, though not equal to that of the bulk-frozen meat. The vacuum-packed cuts were dull on unwrapping but became bright and attractive after standing for some time.

different from each other. When all the treatments are arranged in order of decreasing loss, each of the treatments 1, 2, and 3 can be said to be significantly lower than some, but not significantly lower than all, of the group above it in the list. With the frozen-in-quarter sample the figure given is that for thawing of the standing roast including bone and cannot be compared with the figures for the prepared roasts. An estimate based on the relative weights and areas of cut lean would suggest that the figure given for treatment 1 should be six times as great to bring it into line with the prepared roasts. In view of the crudity of this estimate, and the fact that the figures for the other treatments are subject to errors due to thawing of snow, the data cannot be used to decide whether blast freezing really affected the amount of drip. It appears probable, however, that the combined freezing, storing, and thawing loss per carcass would be greater from the frozen-in-quarter meat than from the wrapped packs.

Table 1.—Weight Losses in Roasts and Grills
Expressed as percentage of initial weight (see text)

Mean Weight Loss	Treatment of Roasts						Treatment of Grills					
	1	2	3	4	5	6	1	2	3	4	5	6
In freezing and storage	(1·66)*	4·63	1·94	0·00	0·31	0·10	(1·66)*	24·62	9·42	6·32	0·25	0·31
In thawing†	0·43	–0·37	1·02	2·62	3·47	3·86	10·20	–3·89	–0·26	–0·24	6·27	6·30
In cooking†	36·7	31·2	33·2	35·5	35·7	32·0	36·9	28·2	34·8	33·3	37·6	32·4

* Estimate (see text). † Corrected for carcass variation.

WEIGHT LOSSES

Figures for weight loss during freezing and storage, in thawing, and in cooking are given for roasts and grills in Table 1. Losses during freezing and storage are given as a percentage of the weight on entering the freezer, those in thawing as a percentage of the fresh weight, and those in cooking as a percentage of the weight before cooking.

Roasts

Considering first the losses in roasts during freezing and storage, the figure for the bulk-frozen material is an estimate based on normal losses for quarters corrected for bone weight. It can be seen that losses are practically negligible for plastic wraps, and there is evidence that even those losses were probably due to faulty sealing. The losses for the greaseproof and unwrapped samples exceed those estimated for the sample frozen and stored in bulk.

As regards losses in thawing the results for the three plastic wraps are not significantly

The gain in weight during thawing of the unwrapped samples should be noted. The effect of this is that the overall loss by the unwrapped roasts is not greatly different from the wrapped samples.

Regarding the losses of weight in roasts due to cooking, there are no significant differences between the values for the different treatments, although it may be of interest to note that the smallest figure was that for the unwrapped samples.

Grills

The figure for weight loss in freezing and storage of grills for treatment 1 (samples frozen and stored in bulk) is again an estimate. It is clear from the figures that there are considerable differences between the various treatments. The unwrapped samples (treatment 2) lost a lot of weight. Those wrapped in wax-paper (treatments 3 and 4) also suffered excessive weight loss, although not as much as the unwrapped samples; the effect of the box in addition to the greaseproof paper is evident. Losses from the samples wrapped in plastic sheets were, however, quite small.

During thawing, as might be expected, the desiccated unwrapped grills absorbed a certain amount of water. The samples wrapped in wax-paper also absorbed water but not to the same extent. The samples wrapped in plastic sheeting were quite different from the other samples in that they lost a fair amount of water, although they were not significantly different from each other.

With grills the slower rate of freezing of the samples in bulk is reflected in a marked increase in the amount of drip. However, for the samples wrapped in wax-paper with and without a box, any consideration of the relation between the rate of freezing and loss on thawing is complicated by the difference between their losses before thawing. The combined losses during freezing, storage, and thawing are obviously smaller when the meat is wrapped in plastic, or in wax-paper and boxed, than when unwrapped or wrapped only in wax-paper.

As regards weight losses during cooking, the desiccated unwrapped samples lost significantly less than the other samples, which do not differ among themselves.

Table 2.—Mean Tasting Scores

Scores are entered in order of magnitude. For further details of the tasting tests and of the scales for scoring see Howard (1956)

	Meat Odour				Meat Flavour				Tenderness		Juiciness		Colour		Acceptability	
	Natural		Foreign		Natural		Foreign									
	Treat-ment	Score	Treat-ment	Score	Treat-ment	Score	Treat-ment	Score	Treatment	Score	Treatment	Score	Treatment	Score	Treatment	Score
Roasts	4	3·68	Not detectable		1	4·33*	Not detectable		1	3·62†	1	4·24	1	3·63	6	1·99
	2	3·76			2	4·56			3	3·99†	5	4·25	3	3·72	4	2·30
	5	4·00			4	4·59			2	4·03†	3	4·30	6	3·75	5	2·37
	6	4·06			6	4·79			5	4·17†	6	4·30	4	3·79	2	2·47
	1	4·08			3	4·85			4	4·73†	4	4·33	2	3·96	3	2·53
	3	4·18			5	4·86			6	4·87†	2	4·60	5	4·00	1	2·71
Grills	6	3·77	4	0·36	5	4·35	4	0·40	1	3·40	2	3·13‡	6	4·23	6	2·56
	4	3·78	1	0·36	1	4·41	6	0·42	2	3·41	1	3·80	4	4·43	3	2·58
	1	3·79	6	0·36	6	4·49	1	0·52	5	3·48	3	3·90	3	4·57	4	2·77
	2	3·95	5	0·43	4	4·50	5	0·56	4	3·75	5	3·93	1	4·59	5	2·85
	5	4·07	2	0·45	2	4·54	3	0·89	3	3·97	4	4·24	5	4·63	1	3·04
	3	4·07	3	0·48	3	4·69	2	1·75‡	6	4·15	6	4·33	2	5·19‡	2	3·83‡

* Sample is significantly different from some, but not all, of the other samples in the group.

† Although no sample or samples could be separated from the others, there was some evidence of heterogeneity in the group.

‡ Sample is significantly different from the next sample in the group.

Each unmarked group constitutes a homogeneous group.

EATING QUALITY

The mean scores for various attributes of eating quality for the six treatments are given in Table 2 for both roasts and grills.

Roasts

The main points of interest with roasts were:

- No foreign flavours or foreign odours were detectable.
- No differences were noted in the strength of meat odour.
- The samples frozen and stored in bulk gave the lowest score for meat flavour. This, while not different from all the rest, was significantly lower than some.
- The tenderness scores exhibited significant differences but the extremes are compatible with the mean. There were no significant differences in juiciness or colour.
- The differences in acceptability were not significant but, as might be expected, they largely followed the differences in flavour and tenderness.

Grills

Definite foreign odours and flavours were detected. The foreign odour was not associated with any particular treatment, but the foreign flavour was significantly greater in the unwrapped samples than in the others. The foreign odour and flavour were described as "kerosene-like". Whether it originated in the packaging material or the surroundings could not be determined, but it was apparently more readily absorbed in the desiccated unwrapped material. That it was not evident in the roasts may or may not have been due to their less extensive desiccation; another possible reason was that although the whole of the grilled steaks were presented to the panel, the outer surfaces of the roasts were discarded and only the centre portions tasted.

The other important points in the eating quality of grills were:

- No differences were evident in natural odour, natural flavour, or tenderness.
- The desiccated unwrapped grills scored significantly lower than the others in juiciness and were significantly darker.

The scores for acceptability followed the pattern to be expected from the individual attributes, the unwrapped samples being significantly less acceptable.

CONCLUSION

The trial has shown that, as far as eating quality is concerned, frozen packaged cuts rate at least as high as cuts prepared from bulk-frozen meat provided the wrap is sufficiently impermeable to water vapour to restrict evaporation during freezing and storage. The ultimate place of pre-packaged frozen cuts in the storage and transport of meat must therefore depend largely on handling costs and the more intangible sales appeal. Handling costs depend largely on local labour conditions and facilities for freezing and packing.

With grills, the freezing rate was high enough to reduce the amount of drip, but with roasts centre temperatures did not reach the freezing point for about two and a half hours and there was no apparent effect on drip. Considering the possibility of using high rates of freezing, apart from the question of packaging as such, in many cases this will be determined as much by economic considerations as by the desirability of reducing drip. For institutional trade and for the requirements of the armed services, however, the best results from the point of view of weight losses are obtained by leaving the meat in bulk form and breaking it up as and when required.

Under the conditions of freezing and storage employed in the trial there was pronounced freezer burn with unwrapped material and slight burn with wax-paper wraps. Weight losses due to evaporation were negligible with the two plastic materials used, namely polyethylene and shrinkable polyvinyl-vinylidine chloride. Overall losses were less for the wrapped prepared grills compared with meat frozen and stored in bulk and there was some evidence that the same applies to roasts.

Eating quality was little affected by the method of wrapping other than that the unwrapped grills were dark and dry when cooked and were less acceptable than the other samples. With roasts the bulk-frozen material was very slightly tougher and weaker in flavour.

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FINANCE FOR RESEARCH ON FOOD PRESERVATION

By R. B. Withers

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

THE Division of Food Preservation and Transport has been gratified at the opportunities it has had over the years to render technical assistance to the food industry and to Government Departments concerned with food. It has sought, since the inception of a Section of Food Preservation in 1932, to build up a store of background information to enable it to cope with a wide range of technical problems of industrial interest. Like other parts of C.S.I.R.O. it would gladly assist industry in the solution of technological problems to a far greater extent than it is now able, if only facilities and manpower were available for the purpose.

There is a growing appreciation of the need for scientific aid in industry. A few large companies are establishing their own research laboratories and other companies less strong financially have joined with related organizations to form research associations, of which there are now four: the Australian Leather Research Association, the Bread Research Institute, the Wine Research Institute, and the Australian Coal Association (Research) Ltd., which are closely associated with C.S.I.R.O.

Many of the companies to which the Division of Food Preservation has given technical assistance, and a number of public institutions with a far-sighted interest in the advancement of food research in Australia, have contributed financially to the work of the Division. Others have made gifts of materials or equipment, or have placed facilities at the disposal of the Division's officers.

The Commonwealth Bank has subsidized research on the preservation of meat and fish, and the Commonwealth Department of Trade (formerly Department of Commerce and Agriculture) has provided finance for work on the dehydration of fruit and vegetables and of mutton. The New South Wales Department of Agriculture has for many years contributed to the cost of investigations on the storage of fresh fruit and vegetables, and more recently to investigations on the freezing of fruit and vegetables. The Queensland Meat Industry Board has for a long time made regular and substantial contributions to the cost of investigations on meat at the Division's laboratory at Cannon Hill, Qld. The Australian Meat Board has made contributions to the capital cost of the Division's laboratories, and has contributed annually towards the cost of investigations on meat since 1937–38. For two years it helped defray the cost of an overseas traineeship in muscle physiology. The former Egg Producers' Council and the Australian Egg Board have subsidized research on eggs, and the latter continues to do so. The Metropolitan Meat Industry Board (Sydney) contributed towards the cost of setting up the laboratories at Homebush in 1937–38 and has since made substantial annual contributions to the work of the Division.

Donations have also been given by the Australian Meat Industries Employees' Union (N.S.W.), Committee of Direction of Fruit Marketing (Qld.), and the Australian Apple and Pear Board. The Division is pleased to place on record the financial assistance generously given by the following companies since C.S.I.R. (the forerunner of C.S.I.R.O.) first undertook research on food preservation in 1932: O.T. Limited, Leeton Co-operative Cannery Ltd., Batlow Packing House Co-operative Ltd., Horitz Fruit Drinks, Vita Foods Supply Company Pty. Ltd., Lewis

Berger and Sons (Australia) Pty. Ltd., Alfred Lawrence and Co. Ltd., W. Angliss and Co. (Aust.) Pty. Ltd., Cottee's Passiona Ltd., Ungar's Peanuts Pty. Ltd., Gray and Donaldson Ltd., and Harry Peck and Co. (Aust.) Pty. Ltd.

During 1955–56 officers of the Division of Food Preservation and Transport made special efforts to acquaint the food industry with the benefits it had derived from scientific research carried out in the Division. They were able to point out that the Divisional laboratories now had a large staff to whom the food industry could turn for technical advice and assistance. It costs over £5000 per annum to provide a research officer with essential assistant staff and equipment and to pay his salary. The cost of the maintenance of the Division's laboratories, with its staff of nearly 40 research officers, now exceeds £200,000 per annum, but so far the food industry has contributed only a few per cent. towards this expenditure. Industry makes a wise investment when it contributes to C.S.I.R.O., for research is in the hands of a carefully selected team of experts who can help producers and manufacturers to reduce wastage or improve the quality of their product. The Commonwealth Government encourages industry to devote portion of its profits to research by accepting donations to C.S.I.R.O. as deductions for income tax purposes.

The response to the Division's approach to industry has been most encouraging, especially when one considers that in many cases the donors have undertaken to make a similar gift for a second and third year. Monies received up to June 30, 1956, amounted to nearly £3000 and several more donations have been promised.

It is with pleasure that we place on record the names of the firms who have made such generous contributions to the appeal. The officers of the Division warmly appreciate their help and hope that the campaign will inaugurate a fresh period of mutually helpful cooperation between the scientist and the industrialist.

LIST OF DONORS, 1955-56

Angliss, W., and Co. (Aust.) Pty. Ltd.
Australian Apple and Pear Board
Borthwick, Thos., and Sons (Australasia) Ltd.
Commonwealth Department of Trade
Cottee's Passiona Ltd.
Fowlers-Vacola Manufacturing Co. Ltd.
Gordon Edgell and Sons Ltd.
Harry Peck and Co. (Aust.) Ltd.
Holbrooks' (Australasia) Ltd.
Jones Brothers, Griffith, N.S.W.
Orange Fruit Growers' Co-operative
Rosella Preserving and Manufacturing Co. Ltd.
Swifts Australian Co. Pty. Ltd.
Wilson Meats Pty. Ltd.

The contributors listed below continued during 1955–56 their generous support for research on food preservation, with contributions amounting to about £6000:

Australian Egg Board
Australian Meat Board
Metropolitan Meat Industry Board (Sydney)
New South Wales Department of Agriculture
Queensland Meat Industry Board.

During the same period the United Kingdom Department of Scientific and Industrial Research shared the cost of investigations at Cannon Hill on chilled and frozen beef, the Commonwealth Canmakers' Association contributed towards the cost of research on electrolytic tinplate at Homebush, N.S.W., and the Commonwealth Department of Trade contributed to investigations on dehydrated mutton. Each of these organizations will continue to share the cost of investigations in 1956–57. During 1955–56 the Division has been undertaking investigations on the effect on citrus fruit of certain methods used to sterilize fruit stung by fruit fly. Finance for this research is drawn from a fund made up of contributions by the Commonwealth Government, the State Governments in New South Wales, Victoria, and South Australia, and the Federal Citrus Council.

ANSWERS TO INQUIRIES

STOP-DROP SPRAYS

Does spraying with 2,4,5-*TP to control pre-harvest drop of apples shorten their storage life?*

In storage trials at Homebush in 1954 and 1955 with Delicious apples there were no obvious differences in storage behaviour between those apples sprayed with 2,4,5-trichlorophenoxypropionic acid and unsprayed apples.

The consensus of opinion from overseas work is that stop-drop sprays do tend to accelerate the ripening of earlier varieties but have little, if any, effect on the maturation of later varieties. There is no good evidence of any direct effect of 2,4,5-TP or similar chemicals used as a stop-drop spray on the storage life of apples. One of the best investigations of this was carried out by Fisher and Edge in Canada.* These workers concluded that the differences, if any, were very small and of no practical importance, but they did remark that significant differences might occur in some seasons.

From a practical point of view it is necessary to emphasize that picking should not be delayed by means of stop-drop sprays if the fruit is intended for long storage. If anything, it would be advisable to pick the fruit a little earlier provided that the usual maturity indices show that it is ready for harvest. It is a common experience to find growers complaining of shorter keeping quality as a result of using these sprays, and then to discover that they did pick somewhat later than usual.

* Fisher, D. V., and Edge, E. D. (1953).—Physiology of fruit in storage. Rep. Fruit Veg. Prod. Res. Comm., Dep. Agric., Canada **1953**: 6–20.

FROST HEAVE IN COLD STORES

What causes frost heave in cold stores and how can it be overcome?

When cold stores operating at temperatures below 32°F are built directly on to the ground, some disturbance is often observed in the foundations after a few years. The floors and walls may crack and there may be considerable movement in stanchions. These faults, although slow in developing, may make extensive and costly repairs necessary if they are allowed to continue unchecked. The cause of frost heave is the freezing and expansion of water held in the soil immediately under the floor. The rate of removal of heat from the soil through the ground floor of the store is greater than the rate at which it can be replaced by conduction from the warmer parts of the ground and leads to freezing of the ground for depths of several feet. This freezing usually begins and is deepest near the centre of any cold floor area and may extend to within a few feet of the outside walls.

The extent of frost heave is affected by many factors such as the temperature of the bottom floor of the store, the type of soil immediately beneath the store, and the outside climatic conditions.

A soil which holds a large amount of water is much more liable to give rise to frost heave. It is important, however, to realize that even the driest type of soil is not free from the danger, as examination of soils where frost heave has occurred has shown that the moisture content is much higher than the normal "saturation" content. This may be caused by migration of moisture through the ground to the frozen area owing to capillary movement and to a difference in vapour pressures.

The frozen area beneath the store will increase during a long period of cold weather and decrease during a warm period. The accompanying expansion and contraction of parts of the soil will probably increase the damage already caused by the initial expansion.

To overcome frost heave it is necessary to ensure that the soil underneath the store does not freeze. This may be achieved in a number of ways:

- Wherever possible the room immediately above the ground should be used for cool, not frozen, storage.
- Where new stores are being constructed an air space ventilated with outside air should be left between the floor of the cold room and the soil. Good insulation at floor level is then essential. These measures will lessen frost heave but will not always prevent it, particularly if the floor area is extensive.
- A method favoured overseas, particularly in the U.S.A., is to provide insulation at floor level and then supply heat to the soil so as to keep its temperature above 32°F. Soil temperatures should not be more than a few degrees above 32°F, otherwise the increase in the load on the refrigeration system is too great. It is important that thermometers be permanently in position to indicate soil temperatures. These should be read periodically and a heating system switched on wherever soil temperatures near 32°F are recorded. Alternatively, the thermometers may be connected to switches which automatically operate heaters. Most heating systems are low-voltage electrical heaters spread over the area where freezing is likely to occur (usually near the centre of a floor area), although mains voltage systems with good electrical insulation are sometimes used.

NEWS from the Division of Food Preservation and Transport

COOPERATIVE RESEARCH ON FRUIT AND VEGETABLE STORAGE

Close cooperation between the Division of Food Preservation and Transport and outside organizations has always been an important feature in the development of food research in Australia. Among organizations with which the work of the Division is linked are the Universities of Sydney and Melbourne, the New South Wales University of Technology, Commonwealth Government Departments, and the State Departments of Agriculture. Cooperative arrangements have sometimes extended to laboratories overseas, a notable case being the Low Temperature Research Station at Cambridge, one of the food research laboratories of the British Department of Scientific and Industrial Research. The Division has been fortunate in obtaining the ready cooperation of industry in many investigations.

Of the activities of the Division, research on fruit and vegetable storage was one of the earliest to be placed on a cooperative basis. Nowadays investigations in this field are carried out in the closest cooperation with the fruit and vegetable industry, the several Departments of Agriculture, and the Universities of Sydney and Melbourne.

At the University of Sydney a Plant Physiology Unit was set up in the Botany School in 1951 to carry out fundamental research in plant physiology and biochemistry and to provide research training for recent graduates. The Unit is run under the joint auspices of the Division of Food Preservation and Transport and the Botany School, University of Sydney. The University of Melbourne has also helped research in plant physiology by providing laboratory accommodation for three officers of the Division at its Botany School.

The technological aspects of fruit and vegetable storage research have been undertaken for many years in conjunction with the Departments of Agriculture in the Australian States, especially New South Wales in which the headquarters of the Division of Food Preservation and Transport are located. The New South Wales Department of Agriculture and the Division are jointly responsible for the Citrus Wastage Research Laboratory at Gosford (about 50 miles north of Sydney), where the causes of wastage in citrus fruit are investigated.

The programmes and results of research on both the pure and applied aspects of fruit and vegetable storage problems are considered by two committees, comprising representatives of the cooperating bodies. The Advisory Committee on Fruit Cool Storage Investigations in New South Wales is made up of representatives of C.S.I.R.O. (Division of Food Preservation and Transport), the New South Wales Department of Agriculture, and the University of Sydney (Botany School). It meets twice a year, and approves the programme of research to be followed by these three organizations.

The Committee for Co-ordination of Fruit and Vegetable Storage Research has on it representatives from C.S.I.R.O. (Division of Food Preservation and Transport and Division of Plant Industry), the Commonwealth Department of Primary Industry, and the Departments of Agriculture in the six Australian States. The Committee, which meets every two years, considers reports and suggestions concerning fruit and vegetable storage research, and coordinates the work. It endeavours to see that all important problems in the handling, storage, and transport of fruit and vegetables are investigated by one or more of the participating Departments, and that there is no unnecessary duplication of research work.

PERSONAL

Mr. H. A. McKenzie, who is in charge of the Division's physical chemistry laboratory at the University of Sydney, left for overseas on July 8 by the *Southern Cross*. Mr. McKenzie will visit laboratories engaged on protein research at Uppsala, Copenhagen, and Liége. At Hamburg he will lecture on some aspects of the research in progress in the Division on the denaturation of proteins. Two papers on analytical chemistry will be presented at the Second Analytical Chemistry Congress of the International Union of Pure and Applied Chemistry, which is being held in Portugal. Mr. McKenzie plans to spend two months with Dr. A. G. Ogston at the latter's protein laboratory at Oxford University, after which he will visit a number of universities and research institutions in the U.S.A.

Dr. E. F. L. J. Anet, who has been working at Homebush on non-enzymic browning in foods, has been awarded a post-doctorate fellowship for one year by the Canadian National Research Council. Accompanied by Mrs. Anet, who is a Technical Officer in the Division of Food Preservation and Transport, Dr. Anet will leave Sydney for Vancouver on R.M.S. *Orsova* on October 5. From there he will travel to Ottawa, where he will engage in research on the chemistry of carbohydrates under Dr. G. A. Adams, of the Division of Applied Biology, Canadian National Research Council.

PUBLICATIONS BY STAFF

Über die Ausbildung von "Freezer-burn" an tierischen Geweben. *G. Kaess. Kältetechnik 8: 107–8 (1956).*

Freezer-burn is a discoloration of the surface of frozen meat brought about by sublimation of ice crystals with little change in structure of the meat so that small air pockets replace the ice crystals. This results in yellowish or greyish areas on the surface. In a study at the Division's laboratory at Cannon Hill, Brisbane, beef livers were used, and the effects of variation in fat content, age, weight losses in storage at 0°C before freezing, and speed of freezing were investigated. The experiments are not yet complete and a fuller account will be published in English later.

In samples which were frozen without loss of weight, freezer-burn of a given intensity developed after a certain small loss of weight per unit area had occurred in storage. The intensity of freezer-burn depended only on the amount of weight loss and not on the rate of loss or the fat content.

Loss of water at 0°C before freezing tends to reduce freezer-burn, but an unusually high rate of loss is necessary to have a large effect on it. Storage for more than four days at 0°C increased the weight loss needed in storage to produce a given intensity of freezer-burn. The effect of water loss before freezing decreased with increasing fat content. High weight loss during freezing will reduce incidence of freezer-burn. It has been observed in practice that areas which are protected against evaporation during freezing, for instance by contact with other pieces of meat, are very susceptible to freezer-burn. The age of the animals is important. Freezer-burn did not occur at all on foetal livers, and livers of calves and yearlings were less susceptible than those of adult animals.

THE ANALYSIS OF SCORES FOR BITTERNESS OF ORANGE JUICE. *G. G. Coote.* Food Res. 21: 1–10 (1956).*

The study of the factors associated with bitterness in orange juice involves the analysis of scores made by taste panels, the mean scores of some juices being such as to extend almost to the lower limit of the scale. The organization of an experiment to obtain sufficient data to indicate a sound method of analysis is discussed. For a scoring scale of 0 to 4 the relationship between the total variance of scores and the mean values is shown to be closely approximated by the function

$$\text{Total variance} = \lambda\bar{x}\,(4-\bar{x}),$$

where $\bar{x}$ is the mean score for a given juice and λ is a constant. A relationship of this nature was suggested by Cochran and has been studied by Hopkins. The transformation arcsin $\frac{1}{2}\sqrt{\bar{x}}$ following from the above relationship is appropriate to suitable group means, and has been used to analyse the data. The analysis of the untransformed group means is given for comparison, and the necessity of the transformation discussed. The performance of the panel is discussed, and the members graded on the basis of generally accepted criteria.

A BIOLOGICALLY ACTIVE FATTY ACID IN MALVACEAE. *F. S. Shenstone and J. R. Vickery. Nature 177: 94 (1956).*

The ingestion of malvaceous plants by hens gives rise to disturbances, which include the development of a pink colour in the white of the eggs when they are cold stored.

* Division of Mathematical Statistics, C.S.I.R.O., working at Division of Food Preservation and Transport, Homebush, N.S.W.

The active principle in Malvaceae has been isolated from the oils extracted from *Malva verticillata*, *M. parviflora*, and cotton seed (*Gossypium hirsutum*). This has been identified as a fatty acid containing 18 carbon atoms and appears to be identical with the acid giving the Halphen colour test.

Partition chromatography yielded enriched fractions of the acid which were fed to laying hens. The eggs produced by these hens showed the typical pink white disorder after cold storage. Results are given for changes in the pH of the white and yolk, increased water content of the yolk, and increased iron and non-protein nitrogen content of the white when compared with unaffected eggs.

INITIAL ABSORPTION OF IONS BY PLANT TISSUE. *A. B. Hope and R. N. Robertson. Nature 177: 43–4 (1956).*

THE ELECTRIC PROPERTIES OF PLANT CELL MEMBRANES. I. THE ELECTRIC CAPACITANCE OF SUSPENSIONS OF MITOCHONDRIA, CHLOROPLASTS, AND CHLORELLA SP. *A. B. Hope. Aust. J. Biol. Sci. 9: 53–66 (1956).*

THE STABILITY CONSTANT OF THE TRIS-1, 10-PHENANTHROLINE FERROUS ION. *H. A. McKenzie. Aust. J. Chem. 8: 569–70 (1955).*

PHOSPHORYLATION AS A POSSIBLE FACTOR IN THE PASTEUR EFFECT IN PLANTS. *K. S. Rowan, D. E. Seaman (U.S. Fulbright Research Student), and J. S. Turner (Botany School, University of Melbourne). Nature 177: 333–4 (1956).*

MOLECULAR WEIGHT OF OVALBUMIN AND OF BOVINE SERUM ALBUMIN IN UREA SOLUTION. *H. A. McKenzie, M. B. Smith, and R. G. Wake. Nature 176: 738 (1955).*

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