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The Australian Wine Research Institute

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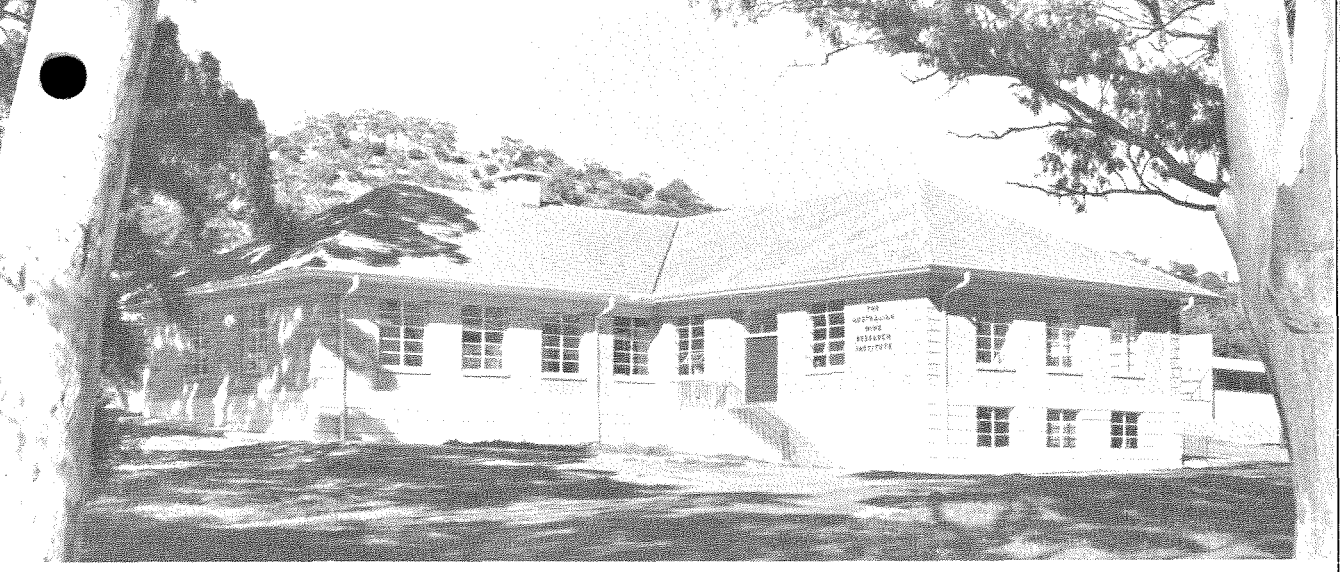
THE development of a research unit specializing in problems of the Australian wine industry dates back to 1934, when the University of Adelaide undertook an investigation of spoilage in fortified wines on behalf of the Wine Overseas Marketing Board and appointed a research officer to carry out the investigation. The work started under Professor J. B. Cleland in the University Department of Pathology in November 1934, but in February 1935 it was transferred to the Department of Agricultural Chemistry at the Waite Institute, where work in agricultural bacteriology had already been started under Professor J. A. Prescott. The research on spoilage of fortified wines was followed by other investigations, and oenological research continued at the Waite Institute for over 20 years.

The Council for Scientific and Industrial Research first became involved in oenological research in 1938 when it granted a travelling studentship to enable an officer to gain overseas experience in this field. At about the same time a C.S.I.R. Committee was set up to give advice and general direction on oenological research. This Oenological Research Committee consisted of one representative from each of four bodies — C.S.I.R., the University of Adelaide, the Wine Board, and the Federal Viticultural Council.

For several years oenological research at the Waite Institute continued under the control of the University and was financed by the Wine Board, but in 1945 C.S.I.R. undertook control of the investigations and shortly afterwards began to share the cost equally with the Wine Board. In 1948, it was decided to extend the scope of the investigations and an additional research officer was appointed in 1949. Further extension of the investigations and increase in staff were not possible until the formation of the Australian Wine Research Institute in 1955.

FORMATION

The Australian Wine Research Institute is a type of industrial research association. It is a Federal organization registered under the company laws of South Australia as a company limited by guarantee and not having a share capital, and has its headquarters in Adelaide. The Institute came into being as a result of the Wine Research Act which was passed by the Commonwealth Parliament in May 1955. Under the provisions of this Act, a sum of £500,000 held by the Federal Treasury in a Wine Industry Assistance Account was transferred to a Wine Research Trust Fund. The money had accrued from a special excise duty levied on fortifying spirit for the purpose of paying an export bounty on fortified wines. The amount transferred to the Wine Research Trust Fund represented portion of the funds which had accumulated in this way when payment of the export bounty was discontinued in 1947. The Wine Research Trust Fund is controlled by the Commonwealth Minister for Primary Industry, and under the terms of the Act he may make available to the Wine Research Institute up to £100,000 from this Fund for approved items of capital expenditure. The remaining £400,000 is invested in approved



The laboratories and administrative offices at Glen Osmond. The pilot winery and storage facilities are in a separate building at the rear.

securities as a source of income for the Institute. In addition, the wine industry contributes £4000 per annum through the Australian Wine Board, and C.S.I.R.O. contributes £3500 per annum.

MANAGEMENT

The management of the Institute is in the hands of a council of nine members responsible to the Minister for Primary Industry. The constitution of the council is defined in the articles of association of the Institute. It consists of representatives of the Australian Wine Board, the Minister, C.S.I.R.O., and the University of Adelaide, and three additional members appointed for their knowledge of the scientific functions of the Institute.

Soon after its formation, the Wine Research Institute took over the responsibilities of the Oenological Research Committee, and officers of C.S.I.R.O. engaged in oenological research at the Waite Institute transferred to the staff of the Wine Institute.

LABORATORIES

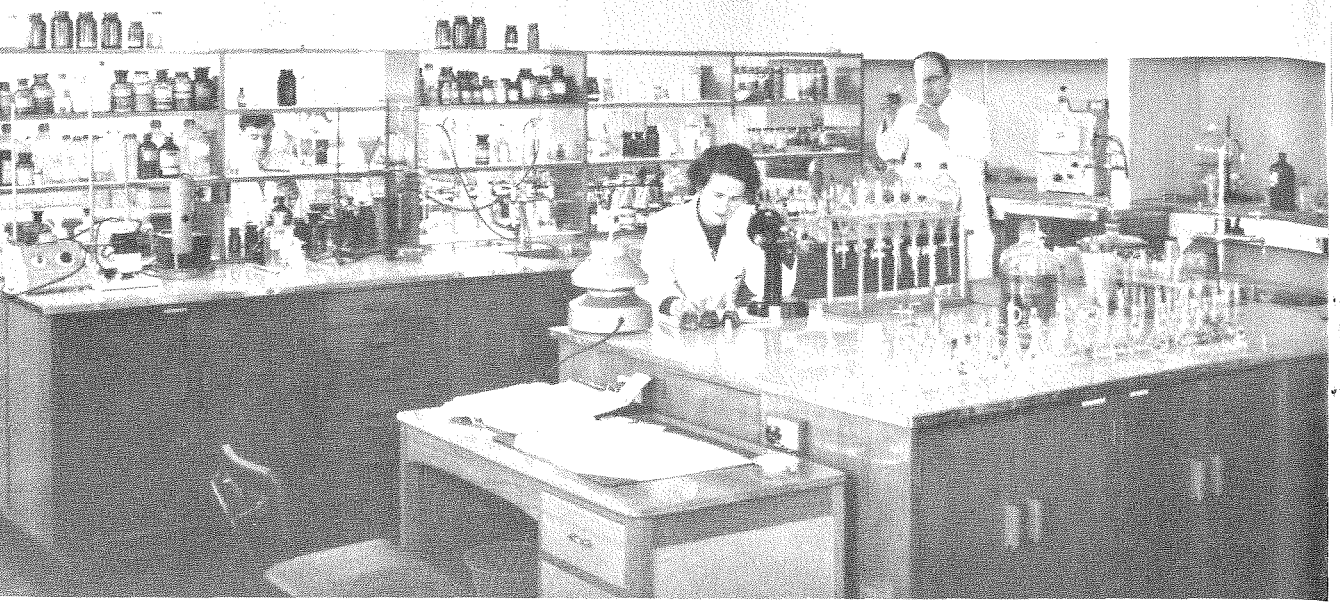
The Waite Institute had for 20 years provided valuable laboratory accommodation for the oenological investigations, but it was obvious that the research programme planned by the Wine Institute would require additional accommodation, and this was not available at the Waite Institute. Thus it became necessary for the Wine Institute to build and equip its own laboratories and pilot winery as one of its first undertakings. These buildings were completed early in 1958 and officially opened on March 28.

The new buildings, some of which are illustrated in this article, are situated on approximately $1\frac{1}{2}$ acres of land made available by the University of Adelaide at the Waite Institute near Glen Osmond, a suburb of Adelaide. The main building is about 7200 square feet in area and houses chemical and microbiological laboratories, offices, storerooms and a library. Adjacent to this is a pilot winery of 3600 square feet which contains a large room for receiving grapes and making wine, and three smaller insulated rooms for maturing wines. There is also a garage and a workshop. Special small-scale winery equipment is being installed and with this it will be possible to make and mature wines in small quantities under closely controlled conditions. The new buildings provide adequate accommodation for the present staff of seven and also allow for reasonable expansion in the future.

FUNCTIONS

The Wine Research Institute was formed for the purpose of conducting and promoting research in connection with winemaking and the growing of wine grapes. However, the State Departments of Agriculture have long been active in the field of viticulture, and this is taken into account in planning the research programme of the Institute.

The functions of the Institute include both research and consultative or advisory work and it is important that a balance be maintained between these activities. A certain



Portion of the chemical laboratory.

amount of work on the day-to-day problems of individual winemakers is justified, since this provides a valuable service to the wine industry and keeps it in touch with the Institute. It also serves to keep the staff of the Institute informed of the technical problems of the industry. However, the performance of these services is not allowed to dominate the activities of the Institute. The main function of the Wine Institute is research and, being a Federal body, it has an obligation to investigate problems of importance to the wine industry as a whole, or at least to a major part of it.

Research by the Wine Institute, like that previously undertaken by the Oenological Research Committee, is concerned chiefly with problems related to the quality of wine, although, of course, the importance of yield and of economic production is recognized. Research under the Oenological Research Committee was concerned with the various changes, both desirable and undesirable, which occur during the making and maturation of wine. The problems studied included bacterial spoilage of wines, the use of film yeasts in maturation of sherry, the testing and selection of strains of yeasts for use in wine fermentations, the prevention of tartrate precipitation in wines, and other microbiological and chemical changes. The research programme of the Wine Institute embraces other projects of this type including a study of the bacterial decomposition of malic acid in table wines. However, the improved facilities now available, particularly the pilot winery, enable other research projects to be undertaken which have not hitherto been possible in Australia. Important among such projects is the testing of grapes for winemaking quality by making them into wine on a small scale under controlled conditions. It is recognized that the quality of grapes for winemaking depends on variety and on the environment under which the grapes are grown, and furthermore that the quality of the grapes is of prime importance in determining the quality of wine. In the older winemaking countries of Europe, satisfactory combinations of grape variety, soil, and climate have been arrived at by long experience, but as yet we know little about the best combinations of such factors to give quality wines in Australia. An investigation of this subject is being undertaken by the Wine Institute in cooperation with the State Departments of Agriculture and the C.S.I.R.O. Division of Soils. In conjunction with this work a study is being made of some of the physiological changes occurring in wines during maturation, with the object of relating these to wine quality.

Financial Support for the Division

IT is with pleasure that we once again place on record the valuable financial support which the Division is receiving from a number of sources.

In the course of the financial year ended June 30, 1958, contributions amounting to nearly £5000 were made by the following firms:

Australian Paper Manufacturers Ltd.
Committee of Direction of Fruit Marketing
Cottee's Passiona Ltd.
Gordon Edgell & Sons Ltd.
G. Centofanti & Sons, Griffith, N.S.W.
Harry Peck & Co. (Aust.) Pty. Ltd.
Jones Bros., Griffith, N.S.W.
Kia-Ora Industries Pty. Ltd.
Kyabram Preserving Co. Ltd.
Matthews Thompson (Trading) Co. Pty. Ltd.
Pick-Me-Up Condiment Co. Ltd.
Raleigh Preserving Co. Ltd.
R. B. Manufacturing Co. Pty. Ltd.
Riverstone Meat Co. Pty. Ltd.
Rosella Preserving and Manufacturing Co. Ltd.
Sidney Cooke (Printing Inks) Pty. Ltd.
Thos. Borthwick & Sons (A'asia.) Ltd.
Unilever Aust. Pty. Ltd.

In addition the Commonwealth Canmakers' Association continued during the year to contribute towards the cost of research on electrolytic tinplate.

The Division wishes also to place on record once again the names of those Government Departments and statutory bodies which have during the year financially supported its work. They are:

Australian Apple and Pear Board
Australian Egg Board
Australian Meat Board
Commonwealth Department of Trade
Metropolitan Meat Industry Board, Sydney
N.S.W. Department of Agriculture
Queensland Meat Industry Board.

Funds for investigation on the sterilization of citrus fruit against fruit fly have again been received through the Commonwealth Department of Primary Industry. These funds have been made up of contributions from the Commonwealth Government, the State Governments in New South Wales, Victoria, and South Australia, and the Federal Citrus Council. The total contributions received from the above sources have amounted to over £14,000.

The money from private industry has been devoted largely to the purchase of laboratory and other equipment needed by the research staff. Up to June 30, 1958, nearly £5000 had been spent in this way. Investigations on the processing of foods have been greatly facilitated by the purchase of a recording potentiometer, by means of which one can rapidly and accurately follow the temperature changes in foods during the course of heat processing. Other equipment which has proved most valuable in processing investigations includes a refractometer, pH meters, and a machine for heat-sealing frozen food packages under vacuum. Contributory funds have been used to purchase the following equipment for research on proteins: a polarimeter, Dewar flasks, and freeze-drying equipment. The work of the chemists and the bacteriologists has benefited by the purchase of manometric gas analysis apparatus, a photo-electric spectrophotometer, and accessories for a special microscope.

The contributions from the Australian Apple and Pear Board, which have been used entirely for apple and pear storage investigations, have enabled the research staff to purchase equipment, and to obtain additional assistance in the laboratory.

The article below summarizes the experience accumulated by the research staff in the laboratories of the Division of Food Preservation and Transport on the performance testing of tinplate containers and lacquers.

Evaluation of Tinplate

ONE aspect of container research which has been undertaken by the Division of Food Preservation over a number of years is the evaluation of new materials for food cans, mainly tinplates and organic coatings. An account of the methods used to test the suitability of these materials for commercial use may be of interest to canners, canmakers, and manufacturers of food can lacquers.

LABORATORY TESTS

Attempts to develop rapid laboratory tests for the evaluation of container materials have generally been unsuccessful. It is difficult to reproduce in an artificial system the wide range of corrosion behaviour shown by processed foods. In addition, the quality of container materials is governed by several factors whose relative importance depends on the product to be packed. A satisfactory laboratory test must take all these factors into account.

Laboratory tests for the assessment and control of individual factors associated with tinplate quality have been more successful and several are in commercial use (Vaurio, Clark, and Lueck 1938; Liebmann 1956; Willey, Krickl, and Hartwell 1956). These tests cannot be used for a general assessment of tinplate quality, since the results show poor correlations with actual packing tests (Liebmann 1956; Willey, Krickl, and Hartwell 1956).

In the absence of suitable laboratory tests, the only satisfactory method for the evaluation of container materials involves making test packs of a suitable range of foods and observing the performance of the containers over a period of storage. Considerations governing the choice, preparation, and examination of test packs are outlined below and illustrated by reference to some specific results of recent container performance tests.

PERFORMANCE REQUIREMENTS

The performance requirements for a new container material depend on the product to be packed and are generally assessed on a relative basis by comparison with the performance of materials of known behaviour.

Internal Lacquers

The various types and functions of internal can lacquers have been discussed in an earlier article (Davis 1955). Both acid-resisting (A.R.) and sulphur-resisting (S.R.) can lacquers should have a good general appearance, with freedom from blushing after processing, good adhesion to tinplate and resistance to damage during can fabrication, and freedom from taint and odour. A good resistance to fabrication damage is particularly important with A.R. lacquers and they should prevent the spread of corrosion from sites of damage. They should also be resistant to pinholing and impermeable to the food product, so as to prevent attack at other places. The main requirement for S.R. lacquers is that they should have good resistance to sulphur staining of the internal surfaces of the cans.

Tinplate

A tinplate is regarded as meeting requirements if its level of performance does not fall below that of the standard or conventional tinplate in commercial use. The acid- and sulphur-resisting properties of the tinplate, both with and without protection by lacquer coatings, should be evaluated on a suitable range of foods using tinplate of known satisfactory performance as a control.

PREPARATION OF TEST CANS

Test cans from experimental types of tinplate are made by normal commercial methods, as are the control cans made from tinplate of known performance.

By E. G. Davis

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

Containers for Foods

Lacquers submitted for testing may be applied to tinplate by flush lacquering made-up cans, or by roller coating tinplate sheets which are subsequently made into cans. The lacquer manufacturer's recommendations relating to dry film weights and stoving schedules are closely followed. Control cans made from the same batch of tinplate and lined with a lacquer of known satisfactory performance are prepared along with the test cans.

Cans lacquered by flushing are likely to give a performance which differs from those lacquered by roller coating. It is difficult to obtain a uniform film by flushing, and the lacquer film is not subjected to the conditions which normally result in some damage to the film during can fabrication. However, the method does provide useful information when used in preliminary small-scale tests designed to distinguish between lacquers with a good or bad performance. Lacquers which give a satisfactory result in this test are then applied by roller coating and submitted to tests on a larger scale.

TEST PRODUCTS

Acid-resisting Lacquers

A.R. lacquers are evaluated by using three test products: acidified beetroot, a berry product such as boysenberries, and a citrus juice such as lemon or orange juice. Acidified beetroot and the coloured berry products are typical examples of a class of highly corrosive foods which are susceptible to bleaching or discoloration of the pigments if excessive corrosion is permitted and are likely to cause hydrogen swelling. Citrus juices have a tendency to soften some lacquer films, resulting in loss of adhesion and peeling of the film, particularly when the oil content of the juice is high.

Sulphur-resisting Lacquers

S.R. lacquers are tested using a modification of the kidneys-in-brine test (British Standards Institution 1944). In this test, 2 oz minced ox kidneys are filled into 301 × 411 cans, covered with a 2 per cent. brine, and the cans closed and processed for 3 hours at 240° F. After standing for 24 hours the cans are opened and the performance of the lacquer assessed from a visual examination of the internal condition of the cans.

Other products, such as meat-in-gravy or sausages, provide satisfactory test materials for sulphur resistance.

Lacquer Taints

The tainting properties of lacquers are evaluated using either water or citrus cordials as test products. In the water test, the cans are filled with water, closed, processed for 30 minutes at 240° F, and stored for 2 weeks at 100° F. Citrus cordials, particularly lemon cordial with sulphur dioxide preservative, are very sensitive to taints from can lacquers. The cordial is filled cold into the cans, closed without vacuum, and the cans stored at 100° F for 2 weeks. After the storage period, properly controlled tasting tests are made on the water or the diluted cordial. The test packs should be tasted in comparison with two control treatments, one using glass containers, and the other using cans coated internally with a lacquer which is known to be free from taint.

Tinplates

Different types of tinplate which are intended to replace conventional types require tests on a wider range of foods. It is necessary to test the acid- and sulphur-resisting properties of the tinplate both with and without lacquer protection. In a series of tests recently made at Homebush to evaluate the performance of 1 lb electrolytic tinplate in relation to standard 1·25 lb hot-dipped tinplate, 11 foods were chosen as test products. The choice of these foods was governed partly by their suitability as test products for a new

Initial Vacuum and Headspace in Test Packs

Product	Number of Cans Examined	Vacuum (in. Hg)		Headspace (ml)	
		Range	Mean	Range	Mean
Beetroot*	8	14·3–15·9	15·2	21·4–25·2	23·5
Boysenberries*	8	18·3–21·4	20·0	28·5–33·0	30·5
Grapefruit juice	4	16·9–18·5	17·7	19·8–23·1	21·2
Green beans	10	15·0–18·5	16·2	23·1–28·0	25·4
Green peas	6	13·7–16·0	15·0	26·8–30·2	28·7
Peaches	8	14·6–17·0	15·8	31·7–36·0	33·9
Tomato pulp	9	11·3–13·6	12·7	21·7–25·7	23·5

* Beetroot and boysenberries were packed in cans lacquered with two A.R. lacquers of local origin applied by roller coating. One (A) was an oleo-resinous stoving lacquer (dry film weight 6·2 mg/sq.in.) and the other (B) was a synthetic epoxy-resin stoving lacquer (dry film weight 6·9 mg/sq.in.). See also p. 70.

type of tinplate, and partly by their economic importance to the canning industry. The range of products covered broadly the low-acid high-protein foods which are responsible for sulphur staining; the high-acid mildly corrosive products normally packed in plain cans; and the high-acid pigmented foods which require A.R. lacquered cans. Because of their commercial importance it was considered desirable to include among the test products green peas, tomato pulp, peaches and a jam.

For the purpose of sulphur-staining tests, green peas (pH 5·6) and meat loaf were packed in plain cans, meat-in-gravy in S.R. lacquered cans, and processed cheese in both plain and lacquered cans. The mildly corrosive foods used were grapefruit juice (pH 3·2), plum jam (pH 3·2), clingstone peaches (pH 4·0), tomato pulp (pH 4·6), and green beans (pH 5·1). Finally, beetroot (acidified pack pH 4·3) and boysenberries (pH 3·3) were selected as test products for the A.R. lacquered electrolytic cans.

PREPARATION OF TEST PACKS

During the preparation of a test pack embracing several container treatments, a number of variables likely to affect the results seriously must be carefully controlled. These variables arise from differences in raw materials, fill-in weights, vacuum and headspace levels, and processing and cooling treatments. It is difficult to eliminate these sources of variation from an experiment, but with certain precautions they may be considerably reduced. The raw material should be of uniform quality and selected from the one source of supply. Liquid materials such as juices, brines, and syrups should be bulked and thoroughly mixed before use. The canning procedure followed should permit close reproducibility of fill-in weights and vacuum and headspace levels among all cans in the experiment. The processing and cooking treatments should also be closely controlled.

Variability in container treatments in an experiment may be further controlled by a proper selection of the cans for the packing operations. The cans from all treatments should be chosen in a predetermined random order and filled, closed, and processed in that order. Variables which cannot otherwise be closely controlled will then be distributed at random throughout all treatments. This is preferable to having uncontrolled variation between treatments which may lead to false results. The simple method of putting all cans of the one treatment through the line followed by all cans from the next treatment and so on cannot be recommended, and results obtained from such an experiment are likely to be misleading.

In a typical experiment at Homebush to study the corrosion behaviour of a number of foods in 1·25 lb/base box hot-dipped tinplate cans, the vacuum and headspace levels shown in the table above were obtained.

In this experiment it was necessary to avoid excessive variation in the vacuum and headspace levels within products rather than between products, and the results indicate that with care this object can be achieved.

STORAGE CONDITIONS

It is customary to store test packs for corrosion studies at an elevated temperature, e.g. 100° F, to accelerate corrosion reactions. The relation between the shelf life at 100° F and the shelf life at average room temperatures cannot be stated precisely, but a ratio of 1 : 4 is commonly used as a rough guide. Sampson (1953) estimated the ratio between shelf life at 100° F and shelf life at 70° F as 1 : 3·5 for grapefruit juice, green beans, and pork and beans, 1 : 4·5 for tomato juice, 1 : 5·5 for tomatoes, and 1 : 7 for peaches. With fruit products, however, Liebmann (1956) obtained evidence that 5-hydroxymethylfurfural, produced by heat degradation of sugars, acts as an accelerator of corrosion. If this is confirmed, observations on fruit packs stored at high temperatures may not permit a reliable prediction of storage life at lower temperatures.

In the experiments at Homebush, a storage temperature of 86° F has been used, and this permits a number of the routine observations on vacuum loss to be carried out in reasonable comfort without removing the cans from the hot room. At 86° F the shelf life is roughly half that at room temperature.

ASSESSMENT OF PERFORMANCE

In this laboratory the performance of test packs is generally assessed by one or more of the following methods:

- Visual observations on the cans
- Determinations of tin and iron pick-up
- Estimations of vacuum loss
- Observations on the number of swells
- Headspace gas analyses.

Visual Observations

Visual observations on the cans themselves are obviously useful for assessing the resistance of tinplates and S.R. lacquers to sulphur staining. The staining in a series of cans may be recorded using a panel of observers and a point scoring system, the scores being subjected to statistical analysis. The degree of feathering and the extent of baseplate exposure resulting from corrosion in plain cans may also be roughly assessed by this method. With A.R. lacquered cans, useful information on the extent of breakdown of the lacquer film may be obtained from a visual examination of the cans, but attempts to estimate the extent of attack on the tin or iron by visual means may be misleading. One reason for this is that sites of severe corrosion may be hidden in the side and end seams.

Tin and Iron Pick-up

Some observations on the tin and iron pick-up by the products mentioned above

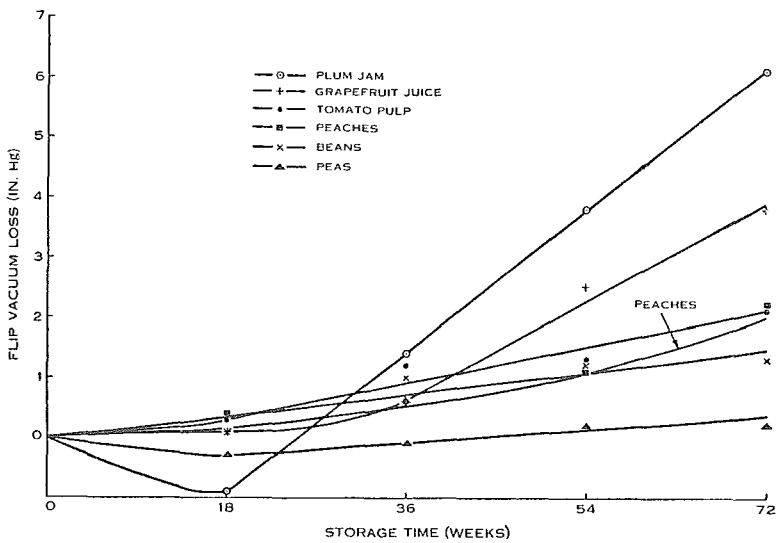


Fig. 1.—Flip vacuum loss in plain cans

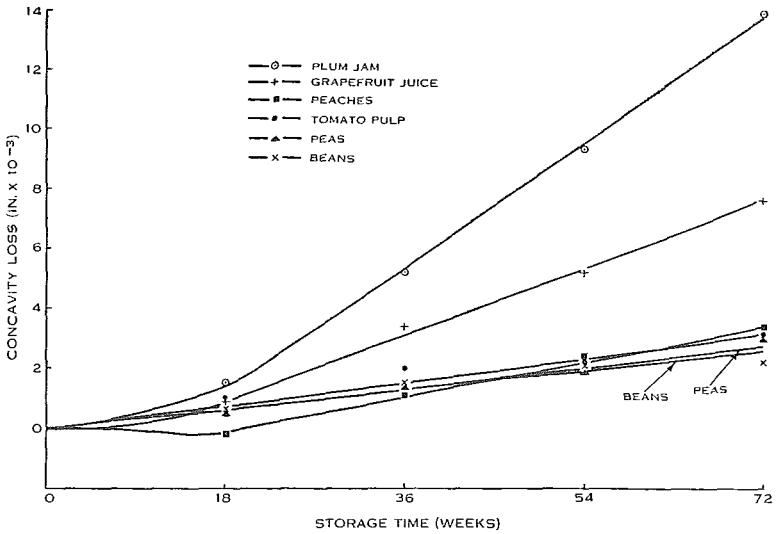


Fig. 2.—Concavity loss in plain cans.

have recently been reported by the author (Davis 1957). However, the method is not often used for following the performance of test packs during storage, because of the relatively large amount of work involved.

Internal Vacuum Loss

Changes in internal vacuum due to hydrogen production are commonly used as an index of tinplate container performance. Vacuum losses in the test packs mentioned, measured by means of a Campden manometer, have already been reported (Davis 1957). The preferred procedure, however, is to estimate internal vacuum without destroying the can by using a flip vacuum tester or a spherometer. With these instruments, a number of cans from each treatment (generally 25–30) may be examined at intervals over the storage period, the measurements being made on the same cans at each examination.

The spherometer used at Homebush has been described by Kefford (1954) and the flip vacuum tester by Davis and Elliott (1958). The results of the flip vacuum and concavity estimations on the eight test packs under discussion are set out in Figures 1–4. Each point on the graphs represents the mean result from 30 cans. The flip vacuum estimations were made on the can end opposite to that used for the concavity estimations.

The flip vacuum and concavity losses for the six products packed in plain cans (Figs. 1 and 2) reveal some differences between products; plum jam and grapefruit juice show a higher rate of vacuum loss than the remaining products.

The flip vacuum and concavity losses for the products packed in lacquered cans (Figs. 3 and 4) in general were small over the early period of storage but increased rapidly over the later period. With boysenberries, the vacuum losses in the two lacquer treatments were similar. For beetroot, the vacuum loss with lacquer A was much greater than with lacquer B. The rate of vacuum loss with beetroot in cans lined with lacquer A increased very rapidly after the examination at 36 weeks, and at 48 weeks there were not sufficient sound cans remaining for measurements to be continued. For similar reasons, no measurements were made on the two boysenberry treatments after 48 weeks' storage.

Number of Swells

The performance of test packs may also be assessed by determining the time required for a certain percentage of the cans in a batch to become hydrogen swells under controlled storage conditions. For instance, the Continental Can Company generally uses 36 cans of each treatment and determines the time for 25 per cent of these to become swells (Skibbe 1955).

Observations made on the test packs of beetroot and boysenberries during storage at 86° F are set out in the table on page 72.

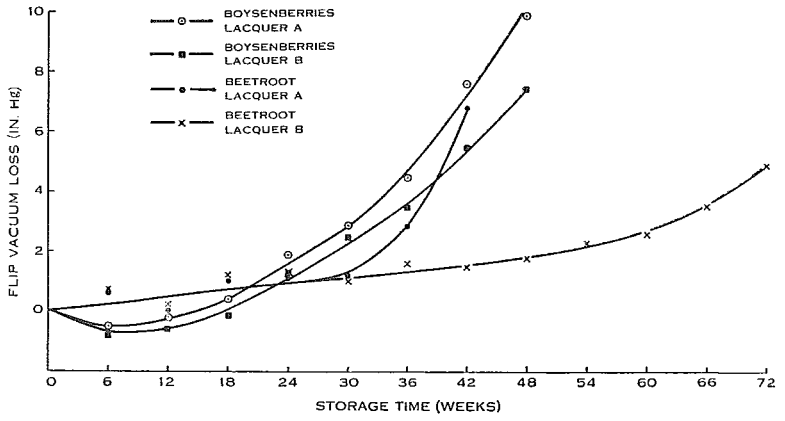


Fig. 3.—Flip vacuum loss in lacquered cans.

Using either the time for the appearance of the first failure or of 25 per cent. failures as the index of performance, the conclusion to be drawn from these results is that lacquer B is superior to lacquer A for both products, but particularly for beetroot.

Gas Analyses

Hydrogen evolution from corrosion reactions may also be followed by analyses of the headspace gases. An instrument suitable for this purpose has been described by Kefford and Davis (1954). It is known that the rate of evolution of hydrogen is closely correlated with the rate of dissolution of iron (Hartwell 1951; Liebmann 1956). Gas analyses have been successfully used at Homebush to follow corrosion reactions but the can-to-can variability is large, particularly among lacquered cans.

INTERPRETATION OF RESULTS

Estimations of the times required for a certain percentage of the cans in a batch to fail is widely used overseas as an index of performance. The method involves little work other than regular examination of the cans for swells, but has the disadvantage that the cans must be stored until they fail. This period of storage may be lengthy, particularly with some packs in plain cans. In addition, observations early in the storage period do not generally permit the final performance of the containers to be predicted.

The possibility of prediction of container performance is, however, offered by the test method based on estimations of vacuum loss during storage, using a flip vacuum tester or spherometer. In experiments at Homebush both instruments have given similar results. Furthermore the estimations are made on

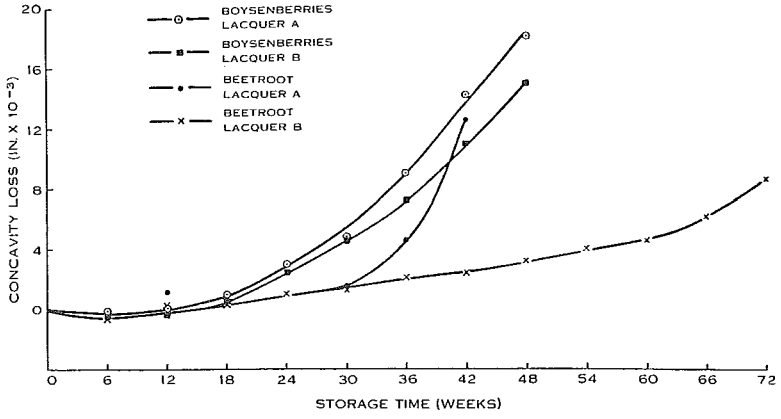


Fig. 4.—Concavity loss in lacquered cans.

Rate of Failure of Food Cans

Product ..	Beetroot		Boysenberries	
Lacquer ..	A	B	A	B
Total number of cans	30	30	30	28
Days to first failure	168	Not reached in 504 days	322	405
Days to 25% failures	278	Not reached in 504 days	383	429

25–30 cans, and the same cans are used at each examination. Hence errors associated with can-to-can variation are minimized.

It is generally believed that in plain cans hydrogen is liberated during the corrosion of iron and that no significant amounts are evolved while tin is being dissolved (Vaurio 1950; Hartwell 1951). Therefore, in plain cans which have not been stored long enough for attack on the iron to commence, the prediction of performance from vacuum loss alone may be misleading; more reliable results may be obtained by following the tin pick-up. The results presented here confirm this view. The vacuum loss with green beans over a storage period of 72 weeks at 86° F showed only small changes compared with plum jam and grapefruit juice, and the increase in iron content was also small. The increase in tin content of the beans, however, was very rapid compared with the other products in plain cans.

The results for metal pick-up by the products (Davis 1957) indicate that the corrosion reactions in plain cans may be closely followed by estimations of the tin content on 4–6 cans at intervals over the storage period. Useful information on the tin pick-up in lacquered cans may be obtained similarly, but the pick-up of iron is generally of greater importance in lacquered cans. However, the pick-up of iron in lacquered cans usually shows large can-to-can variation, and it is necessary to analyse a larger number of cans at each examination to obtain a reliable result.

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CORRIGENDA

VOLUME 14, NUMBER 1

Page 12, column 2: The measurement designated h_3 is not the reading of the mercury level in the sliding arm of the Campden manometer, but the difference between the mercury levels in the fixed and sliding arms.

VOLUME 18, NUMBER 1

Page 11, article headed "Discoloration of Canned Pears", second column, line 11: *For* picking *read* peeling.

VOLUME 18, NUMBER 3

Page 54, Table 6: *For* Initial ascorbic acid concentration, 1 per cent. *read* Initial pantothenic acid concentration, 1 per cent.

Page 54, Table 7: *For* Initial ascorbic acid concentration 0·5μg/ml *read* Initial folic acid concentration 0·5μg/ml.

Tomatoes for Processing

By P. W. Board

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

FOR some years the Division of Food Preservation has made comparative studies of the processing characteristics of tomato varieties. In connection with this programme the investigators sought, from a number of Australian processors, information on the supply and quality of tomatoes used by the industry. Accordingly, a questionnaire was sent to nine of the larger tomato processors in New South Wales, Victoria, South Australia, and Western Australia. The canneries included in the survey were either situated in, or were drawing tomatoes from, the chief growing areas in each State. Of the nine canneries, four were in three main growing areas, and the other five were in capital cities.

All the canneries which received the questionnaire supplied answers to every question, and thanks are due to all of them for their readiness to supply information which will materially assist in the planning of future work. With the permission of the cooperating processors, the information has been collated and summarized. Although somewhat incomplete and generalized, it is hoped that the survey will be of interest to the tomato processing industry.

● **Who grows tomatoes for the canneries?**— Most of the tomatoes processed by the Australian industry are grown under contract by independent farmers. Some canneries supplement their supplies by buying from markets, or from growers who are not under contract. Only one of the nine canneries in the survey grows a proportion of its tomatoes on its own farms; another cannery used to grow tomatoes on leased farms but has since discontinued this practice. At least three of the nine canneries assist growers by such means as supplying seedlings, advising on field problems, and providing a spraying service. Assistance of this nature probably benefits both grower and canner since it leads to improvements in yield and quality.

● **Is the contract system satisfactory?** — Although most of the tomatoes processed in Australia are grown under contract, some canners, especially those who obtain fruit from areas within easy reach of fresh markets, indicated that the contract system is not entirely satisfactory.

In a report by the Bureau of Agricultural Economics (1957) dealing with economic aspects of the tomato processing industry in Victoria, specific mention is made of the contract system in these terms:

"There is widespread dissatisfaction on all sides as to the workings of the contract system. The degree of dissatisfaction depends on the type of contract available, but one firm appears to be establishing more stabilized relations with its suppliers . . . They [the contracts] do not protect the growers against price fluctuations or ensure disposal of the entire crop . . . and the processors find that contracted supplies are not forthcoming for reasons [of] leakages to the fresh fruit market and to other processors.

"The main elements on which an improved contract system could be founded include a method to establish some predetermined basis for adjusting prices as total supplies vary; the establishment of a grading authority and grading standards; provision for sale of the entire product of an area rather than a specified quantity; . . ."

It is interesting to note that a raw tomato grading system was instituted by the Department of Agriculture in Victoria during World War II and that a similar system operates at the present time in U.S.A.

In answer to our questionnaire one canner, who has to compete with the fresh fruit market and other canneries for raw material, made special reference to the need for establishment of a raw tomato grading system. It was his opinion that quality grading was a more important problem than the need for finding more satisfactory varieties. One cannery, which is a considerable distance from the competing fresh fruit market, has instituted its own grading system which is reported to work satisfactorily.

● **How frequently are crops harvested, and what determines frequency of harvesting?** — In general crops are harvested about once a

week, but in hot weather when the fruit is ripening quickly they may be harvested every three days or even more frequently. Weather conditions and availability of labour (more pickers are available in the week-ends) are the two main factors determining frequency of harvesting, although variety and prices also have an effect. Most canneries try to regulate their daily intake of tomatoes by a clause in the contracts with growers, or by restricting the supply of field boxes to growers.

● **What are the main processing varieties, and what varieties are preferred by canneries?** — Information on varieties used by the industry and varieties preferred for pulping, juicing and canning whole is summarized in the table below.

One of the most interesting points arising from the answers obtained to questions about the canner's preference for tomato varieties was that some canners drawing fruit from the same growing area prefer different varieties. For example, one cannery situated some distance from a growing area in New South Wales preferred Tatinter and Pearson tomatoes, while a cannery within the area preferred Tatura Dwarf Globe. These preferences may be associated with the fact that Tatura Dwarf Globe is reputed to have a fragile skin which cracks easily during transport. In a Victorian district one canner preferred Tatinter while another preferred Burwood Wonder.

● **Why do canners have different preferences for varieties?** — Unfortunately, from information available from the survey, it is not possible to determine the basis for the different preferences. Several factors probably contribute: canners may differ in their ideas of what quality factors are important in a processing tomato, or they may not have made accurate assessments of the varieties they process. Another factor which may influence a canner's choice is the grower's preference for a particular variety which, in many areas, will obviously affect the quantity of raw material available for processing.

● **Are egg-shaped tomatoes popular in the industry?** — Special reference was made in the questionnaire to the egg-shaped varieties, San Marzano and Red Top. San Marzano tomatoes, which were at one time used for

Tomato Varieties Used for Processing

State	Main Varieties Processed	Main Varieties Preferred for:		
		Pulping	Juicing	Canning Whole
New South Wales	Tatura Dwarf Globe* Tatinter* Pearson Grosse Lisse Urbana Earlipak Red Top	Tatura Dwarf Globe Tatinter San Marzano Red Top	Tatura Dwarf Globe Pearson Urbana Earlipak	Tatura Dwarf Globe Pearson Grosse Lisse Earlipak Urbana Red Top
Victoria	Tatinter Burwood Wonder KY1	Tatinter Burwood Wonder Tatura Dwarf Globe	Tatinter Burwood Wonder	Tatinter Burwood Wonder
South Australia	Tatinter Grosse Lisse Red Top	Red Top	Tatura Dwarf Globe	Tatura Dwarf Globe
Western Australia	Geraldton Wanneroo Pearson Grosse Lisse	Grosse Lisse Wanneroo	Pearson Wanneroo	Geraldton Wanneroo

* In Murrumbidgee Irrigation Area only.

pulping by some canneries and are still preferred by one cannery for sauce manufacture, have now been discarded because of their small size and susceptibility to blossom end and internal rots.

Some canners indicated that the egg-shaped varieties are not popular with the growers because of the high cost of picking and because of their late maturity which, in some areas, results in large quantities of fruit remaining unripe on the vines at the end of the season.

The new egg-shaped variety, Red Top, appears to be gaining in popularity as a pulping tomato, and one cannery has successfully used Red Top in its whole peeled pack. It is interesting to note that in Italy egg-shaped tomatoes such as San Marzano are the type most commonly used for canning whole; the elongated shape of the fruit is reported to facilitate peeling (Goose 1958).

● **What qualities do canners consider to be most important in processing tomatoes?** — In general, canners agree on the characteristics desirable in a processing tomato. Those favoured by the nine canneries may be summarized as follows:

Pulping tomatoes: High soluble and insoluble solids content. High pectin content. Good colour and flavour. Smooth skin to facilitate washing.

Juicing tomatoes: Good colour and flavour. High Vitamin C and low to medium insoluble solids. Fruit should ripen evenly and be free of cracks.

Canning tomatoes: Good colour and flavour. Smooth skin, even ripening, small core, and firm texture. Round shape and medium size.

● **Are certain varieties reserved for processing into special products?** — With the exception of egg-shaped tomatoes, which are generally reserved for pulping, canneries do not reserve particular varieties for special products. In practice, the general run of canning tomatoes are quality graded on arrival at the factory. The perfect tomatoes of medium size are canned whole, and perfect tomatoes which are too large or too small for this purpose are canned as juice. The remaining fruit of processing quality is pulped.

In all but one of the nine canneries surveyed, pulp production absorbs 60–90 per cent. of the total tomato production; the ninth cannery pulps about 25 per cent. of its tomato intake. Juice production accounts for 5–25 per cent. of the tomato intake of eight canneries, while again the ninth cannery is unusual in using 60 per cent. of its tomatoes for juice. The proportion of the total production of tomatoes used for canning whole varied from 0 to 30 per cent. In most canneries production of whole peeled tomatoes was reported to be limited by consumer demand, but one canner indicated that the supply of suitable raw tomatoes was the limiting factor in some seasons.

● **Are varietal characteristics of major importance in the processing of tomatoes?** — The survey has given some apparently conflicting information about the relative values of different varieties for processing. Although most canners have expressed a preference for certain varieties for particular products, all canners state that they obtain raw material for juice, pulp, or whole canned tomatoes by quality grading the general run of fruit received at the factory. Moreover different canners processing tomatoes from one growing area have expressed preferences for different varieties.

From the practical point of view it appears that canners are not critical of variety as long as the quality of the fruit is reasonable. In New South Wales for example, most canners would consider that sound Tatinter, Tatura Dwarf Globe, Pearson, and Grosse Lisse tomatoes are acceptable for processing even though the flavour or soluble solids content of these varieties may be different. This attitude explains to some extent the interest some canners have in the introduction of a quality grading system for fresh tomatoes. Further, since most tomatoes are grown under contract by independent growers, canners are only indirectly concerned with some important varietal characteristics, such as yield and disease resistance. It appears, however, that both canners and growers would benefit if more were known of the varietal characteristics, especially yield, of tomato varieties.

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Changes During Freezing

IT is well known that frozen fish will remain fresh much longer than chilled fish. This is because the activity of the agencies responsible for spoilage is retarded or eliminated at the lower temperatures. Adverse changes do, however, take place in fish during frozen storage, and may eventually lead to its rejection.

When fish is rapidly frozen and immediately thawed few changes are apparent, apart from some exudation of muscle juice or "drip" from cut surfaces, perhaps a slight softness of texture, and some opacity or milkiness in the lens of the eye. If the unprotected surfaces of the fish are exposed during freezing, surface drying may cause loss of bloom. None of these changes, irrespective of the speed of freezing, can be detected, even by expert tasters, if the fish is cooked immediately after thawing. If, however, the fish is frozen for a long time undesirable changes in flavour and texture may become so pronounced that they will be detected without difficulty even by inexperienced tasters, and will ultimately lead to rejection of the fish.

With the exception of the natural increase in volume which occurs during freezing, all of the changes taking place in frozen fish are influenced in varying degrees by:

- Freshness of the fish at the time of freezing
- Treatment of fish before freezing
- Freezing conditions, particularly rate of freezing
- Temperature and duration of frozen storage
- Thawing and handling
- Species of fish

IMPORTANCE OF FRESHNESS

Fish begin to deteriorate in quality immediately after death, and changes take place in appearance, odour, flavour, and texture as the holding time increases.

The first discernible change is loss of the aroma and flavour characteristic of the particular species, but other changes due mainly to bacterial and oxidative agencies follow. Although bacterial growth practically ceases after the temperature of the fish has been reduced to about 20° F, the bacterial end-products produced prior to freezing are retained in the flesh, and these may promote chemical changes which adversely affect odour and flavour.

Similarly the oxidative changes leading to rancidity in oils, which may have taken place before freezing, will affect the frozen product. Even though rancidity is not apparent before freezing, the body oils may already have passed through the so-called induction or lag period of oxidation and consequently be more susceptible to the rapid onset of rancidity during frozen storage. In the course of holding before freezing, the texture of the flesh undergoes changes which cause the cooked fish to be "dry" or tough. These changes are carried over into the frozen material and superimposed on those normally occurring in frozen storage.

Fish in the "feedy" condition at the time of catching rapidly develop softening of the flesh surrounding the gut, and off-odours result. Even when the intestinal tract is comparatively free from food, stacking of the fish to any depth without ice may cause the flesh to take up pronounced off-odours within a few hours, and these will be noticeable in the frozen product.

In some species the rate of post-mortem autolysis, which causes softening of the flesh, is so rapid that freezing must be commenced within a few hours of death. After thawing, these species will again show rapid softening and breakdown in texture. The flesh of some live fish is sometimes infected by a protozoal parasite which is capable of producing an extremely rapid softening and breakdown of the flesh within a few hours of death. Prompt freezing will inactivate the proteolytic enzymes from this organism, but their activity will be restored on thawing.

The exudation of drip from cut surfaces is greater when the fish has been held for long

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and Frozen Storage

periods before freezing. This is true even if the fish has been held in the round.

TREATMENT BEFORE FREEZING

The methods of dressing and preparing the fish will influence its behaviour during freezing, storage, and thawing.

(1) The extent of the bacterial contamination at freezing depends on the history of the fish and the efficacy of the methods used to reduce the population of bacteria on it. This will have some influence on the changes occurring during frozen storage, and pronounced effects on the rate of bacterial spoilage in the thawed product.

(2) The desiccation of fish surfaces during freezing and storage will be influenced by the methods of packing, and the wrapping materials and containers used.

(3) The development of oxidative rancidity will depend largely on the success of packing methods which may be used to exclude atmospheric oxygen from the package, and to some extent on the use of anti-oxidants.

(4) As already mentioned drip is greater when the fish is held for a long time before freezing. It may, however, be reduced by immersing the fish in anti-drip solutions. These will be discussed in the next article in this series.

EFFECT OF FREEZING

When the flesh temperature falls to about 30° F, freezing begins and ice forms. During the so-called latent period of freezing the temperature remains in the region 30–23° F and about 85 per cent. of the total water in the flesh is frozen. The temperature of the flesh then falls more rapidly towards that of the surrounding medium and more ice is formed. At 15° F approximately 90 per cent., and at −5° F about 94 per cent., of the total water is frozen.

If the temperature of the fish is reduced slowly before freezing, bacterial growth may reach a level at which spoilage becomes apparent. This is more likely to occur when the initial bacterial populations are high. A considerable fall in rate of growth of bacteria takes place when the temperature falls to about 30° F, and at 20° F growth virtually ceases. During freezing and frozen storage some of the bacteria present in the fish at the time of freezing will die.

Oxidative changes involving loss of aroma and the development of rancidity in the oils will continue during the initial temperature reduction, but they are likely to be of significance only if the rate of cooling is very slow.

Drip formation will be greater as the direct result of freezing and will increase as the time to pass through the so-called critical zone (30–23° F) is increased.

Unprotected surfaces of fish exposed to dry cold air moving at relatively high speeds, particularly if the temperature is reduced slowly, will be dried appreciably during freezing.

When fish are frozen by direct contact with liquids such as salt brines the problem of salt penetration into the flesh arises. Tuna, for example, are often frozen in salt brine and held there for several weeks. Under these conditions the uptake of salt is too great even for canned products prepared from the precooked fish. Salt absorption is much greater in non-oily than in oily fish, especially after freezing is completed. The salt uptake is often high enough to bring about a marked increase in the rate of development of oxidative rancidity in the surface body oils, and also to make it difficult to produce a satisfactory ice glaze on the surface on dipping the frozen fish in water.

EFFECTS OF FROZEN STORAGE

During frozen storage the following changes may take place: alterations in surface colour, surface drying, loss of natural aroma and flavour, development of off-odours and off-flavours, alterations in texture, and some increase in drip formation.

Deterioration in all these respects, with the possible exception of increased drip, is directly dependent on storage temperature and duration of storage. The rate of change will be approximately halved for each reduction of 18° F. This relationship will be dealt with in a later article in this series.

Alterations in surface colour are caused partly by oxidative changes affecting the natural pigments, but they may also be due to the formation of brown methaemaglobin from blood, or to the yellowing and browning associated with advanced oxidative rancidity in the body oils.

Surface drying may be so severe that the appearance of the fish is adversely affected, as in the condition known as "freezer-burn". Surface drying may also permit atmospheric oxygen to enter the surrounding tissues more easily, and cause dryness of texture in the fish.

One of the first changes noticeable in fish during frozen storage is the loss of the natural aroma and flavour characteristic of the species. The mechanism concerned in these changes is not thoroughly understood although oxidation is believed to be involved.

Development of off-odours and off-flavours is largely due to the production of rancid end-products during oxidation of the oils. The maximum storage life of frozen fish, even those species containing relatively low concentrations of body oils, is often limited by the formation of these objectionable substances. The addition of salt to the fish before freezing may accelerate this type of deterioration, and anti-oxidants may retard it. Frozen fish may also acquire off-odours and off-flavours from the walls and floor of the store and from other stored foods.

During frozen storage the firm elastic flesh of the unfrozen fish may deteriorate, so that on thawing it is spongy and friable. On filleting or splitting the frozen fish, a ragged surface is obtained, and this drips freely on thawing. After cooking, the thawed flesh will be lacking in elasticity. It will at first be sloppy to the palate, and then dry and fibrous.

The texture of most fishery products cooked prior to freezing will deteriorate during storage more rapidly than similar uncooked material.

THAWING FROZEN FISH

It is often necessary to thaw frozen fish to enable the individual fish or fillets to be separated from frozen blocks, and to permit operations such as filleting, splitting, and smoking.

There is no clear evidence that fast thawing gives a better quality product than slow thawing. If, however, the thawing is extremely slow the outer layers of thick frozen blocks may deteriorate while the deeper layers remain frozen. Fast thawing should, however, make it possible to obtain more uniform quality in the fish or fillets from a particular lot. This is particularly important if the frozen fish are to be thawed, filleted, and refrozen. If thawed fillets or split fish are held some time before cooking, drip will continue unless the flesh has been specially treated. Appreciable drip during thawing will cause some "dryness" in the cooked flesh.

After thawing, the fish again becomes subject to bacterial spoilage by the micro-organisms which have survived freezing and frozen storage. The flesh of thawed fish does not, however, spoil more rapidly than fresh unfrozen fish with a similar population of bacteria held at the same temperature.

INFLUENCE OF TYPE OF FISH

Certain species of fish are known to be more suitable for freezing and frozen storage than others. In general, fish with a naturally high content of body oil are more prone to spoilage on account of rancidity. Apart from this, certain oily species, for example Australian mullet, are particularly susceptible to oxidative rancidity because of the chemical constitution of their body oils.

The rate of deterioration in texture of the flesh of oily fish is usually slower than in non-oily species.

Drip losses are generally higher in fish with coarse-textured flesh. The flathead and edible sharks are examples among Australian species.

SUMMARY

The main deteriorative changes in frozen fish are, in approximate order of importance:

(1) Development of off-flavours
(2) Development of tough texture
(3) Loss of natural aroma and flavour
(4) Loss of drip
(5) Development of freezer burn.

Methods for reducing these changes and so maintaining quality will be the subject of the next article in this series.

NEWS FROM THE DIVISION OF FOOD PRESERVATION AND TRANSPORT

EXPERIMENTAL BLAST FREEZER

The Meat Research Laboratory at Cannon Hill, Queensland, is engaged on a programme of improving techniques for handling frozen beef. As the thermal properties of beef carcasses in cold air streams, particularly at freezing temperatures, are not well known, a blast freezer has been installed and equipped with instruments to facilitate the collection of data on these properties.

Basically the blast freezer is an insulated air tunnel equipped with a variable-speed fan capable of circulating air at speeds up to 1000 ft/min in the free space of the working section, which can accommodate a side of beef in quarters, or up to 500 lb of packaged meat. The refrigerating equipment can remove up to 30,000 B.t.u./hr at temperatures down to —40° F. There are two banks of cooling coils, one at each end of the tunnel, and the overall design is such, that with maximum air speed and a full load of meat, the rise in air temperature from end to end is not more than 1° F. The refrigeration coils are operated at constant suction pressure and are also controlled by an on-off solenoid valve. With this arrangement the temperature at any point in the air stream does not vary more than 2° F.

Thermal Properties of Meat

The desired data on the thermal properties of meat are obtained by making an intensive survey of conditions throughout the tunnel and the load of meat. A recorder, in conjunction with a 50-point selector switch, is used to obtain temperature readings from thermocouples at regular intervals of time. These data are used to estimate:

- The variation in the cooling load during the freezing of the meat.
- The heat transfer coefficient at the meat surface.
- The thermal conductivity of the meat.

As the temperature differences in the working section of the tunnel are small it is difficult to estimate the refrigeration load from the normal temperature readings. Accordingly a multi-junction arrangement of 12 thermocouples is used to measure the temperature differences directly. Although temperature differences of the order of 0·05° F can be recorded continuously, random changes in the values make it difficult to obtain reliable data except when the temperature difference is comparatively large, as at the beginning of a run. More reliable data are obtained by measuring the rate at which the temperature of the air in the tunnel rises during the short intervals when the refrigeration has been cut off by the solenoid valve. Rates of the order of 1·5° F/min are involved, and these are recorded with an accuracy of the order of 0·01° F/min. Calculations from the data so obtained are checked by another method in which a self-starting electric clock, operated by the same thermostat which controls the solenoid valve, integrates the time intervals for which the solenoid valve is opened. From this, using the relationship which has been determined for the refrigeration input at constant suction pressure for given air speed and air temperature, the refrigeration load can be determined at any stage of the freezing.

Weight Loss in Meat

Finally, it is important to know the weight loss from the meat corresponding to any set of freezing conditions. For this purpose the freezer is equipped with a suspension for beef quarters which enables their weight to be measured by resistance strain gauges. This electrical system of weighing enables the weight loss to be determined at any time without interruption of the cooling process. The uncertainties which may arise in the electrical circuits are avoided by the use of a null method, so that the overall weight suspended is maintained constant by the addition of a non-volatile oil to a container attached to the carcass. The quantity of oil transferred gives a measure of the weight loss at any stage.

PUBLICATIONS BY STAFF

Morphological, Anatomical, and Physiological Changes in the Developing Fruit of the Valencia Orange, *Citrus sinensis* (L.) Osbeck. Joan M. Bain. *Aust. J. Bot.* **6**: 1–24 (1958).

Measurements of fruit radius and peel and pulp width, as well as determinations of fresh weight, dry weight, moisture content, total and protein nitrogen content, and respiration rate, were made throughout two growing seasons on Valencia oranges from the Gosford district of New South Wales. Soluble solids, sugar, and acid were also determined in the juice. Anatomical changes during development were investigated throughout one season.

Development could be divided into three stages, corresponding to changes in growth rate and coinciding on a calendar basis in both seasons. Stage I was the cell division stage which lasted from blossoming to mid December. Stage II, from mid December to mid July, was a period of rapid growth and cell enlargement. Stage III, the maturation period, lasted approximately seven months.

Studies in the Preservation of Shell Eggs. VIII. The Effects of the Treatment of Shell Eggs with Oil. F. S. Shenstone and J. R. Vickery. *C.S.I.R.O. Aust. Div. Food Pres. Transp. Tech. Pap.* No. 7 (1958).

Most eggs intended for long storage in Australia or for export to European markets are coated with odourless, colourless mineral oil, which is applied immediately after candling and grading on the egg floor.

Many investigations have shown that the oil coating greatly reduces the loss of moisture from eggs during storage, and hence results in small air cells, but evidence on other benefits has been conflicting. In general the results of the experiments described in this paper show that appreciable benefits are obtained by oil coatings only when the oil is applied within 24 hr of laying. These benefits, in respect of greater yolk index values and better appearance of the eggs when opened, are apparent only when the period of cold storage is prolonged, and particularly when cold storage is followed by a period of holding at atmospheric temperatures.

When the period elapsing between laying and the application of the oil extends to 3–4 days, the only benefit is higher yolk index values. When the period elapsing between laying and oiling exceeds about 4 days, there are no significant benefits to be obtained from oiling.

Under all conditions of application, oiling does not retard the normal onset of stale flavours during storage. Oiling does not reduce, and in some instances may accelerate, the rate at which thick white decreases during storage.

The addition to the oil of aluminium or magnesium stearate (or both) does not alter the results summarized above.

Various grades of coating oils are significantly more efficient than others in reducing the loss of moisture from eggs during storage. The addition to the oil of aluminium and magnesium stearates further reduces the rate of loss of moisture.

It is concluded that, under the conditions existing in the Australian egg industry, the only benefit to be derived from the application of oil is in the reduction of the rate of weight loss.

Liberation of Tyrosine Hydroxyl Groups in Urea Solutions of Bovine Serum Albumin and Ovalbumin. A. N. Glazer*, H. A. McKenzie, and R. G. Wake*. *Nature* **180**: 1286–7 (1957).

The process of denaturation of proteins, so important in the preservation of foods by heat or cold, is being investigated in the Physico-Chemical Unit of the Division of Food Preservation and Transport by following changes in various properties which depend on the structure and state of aggregation of the protein molecule. The liberation of tyrosine hydroxyl groups has been studied by examining the changes with time in the ultraviolet absorption spectra of bovine serum albumin and ovalbumin under different conditions of pH, both in the presence and absence of urea.

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Copies of 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, UM 8938.)