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## CONTENTS

	PAGE
Control of Enzymatic Browning in Frozen Peaches— <i>I. J. Tinsley</i> ..	65
Further Aspects of the Preparation and Storage of Sugared Fruit— <i>D. McBean</i> ..	70
Control of Mould Wastage in Citrus Fruit— <i>J. K. Long</i> ..	73
Waste Disposal in Canneries— <i>F. E. Atkinson and C. C. Strachan</i> ..	75
Protective Wrapping of Frozen Skinned Rabbits— <i>J. R. Vickery</i> ..	79
Answers to Inquiries ..	81
News from the Division of Food Preservation ..	83
Tin in Canned Foods ..	86
Index to Volume 13 ..	87

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# Control of Enzymatic Browning in Frozen Peaches

By

I. J. TINSLEY\*

## INTRODUCTION

Special precautions are necessary in the freezing of peaches to ensure that the fruit does not brown during processing, storage, and especially on thawing. Various factors influence the rate at which peaches turn brown: in this article it is intended to summarize the factors which influence enzymatic browning and to review the various methods which may be used for its control.

## THE ENZYMATIC BROWNING OF FRUIT

Peaches are representative of a group of fruits, which, when subjected to mechanical or physiological injury, undergo rapid colour changes, which will continue during frozen storage and thawing. The enzymatic nature of this change has been recognized for some time but few data have been published on the characterization of the enzyme systems involved, or on the chemical nature of the reaction.

The most important if not the only enzyme system directly involved is polyphenol oxidase, more commonly referred to as "polyphenolase" or "phenolase", which catalyzes the oxidation of phenolic substrates by molecular oxygen. It is suggested that the first step in the reaction is the oxidation of the phenolic substance to a quinone which subsequently oxidizes other constituents present. Whether the final pigmentation is due to the oxidation of the original phenolic substrate or to the induced oxidation of other phenolic substrates has not been established. The presence of polyphenolases has been demonstrated in many fruits including peaches, apricots and apples which are all subject to enzymatic browning. Polyphenolases are generally unstable and have not been isolated in a pure form. There are therefore few data in the literature on the properties of peach phenolase.

It was suggested by Balls and Hale (1935) that the enzyme peroxidase was responsible for the darkening in apple tissue, and they showed that apple tissue would darken in the absence of air if hydrogen peroxide were added. The presence of hydrogen peroxide in apples is rather doubtful, and further, Ponting and Joslyn (1948) demonstrated that peroxidase was not essential for the darkening of apples. They observed that darkening occurred when purified apple polyphenolase was added to boiled apple juice in which the peroxidase had been destroyed. It appears therefore that peroxidase plays little, if any, part in the enzymatic browning of apples, and this is probably also the case with peaches.

Little is known of the chemical nature of the phenolic compounds which undergo oxidation as most of the work on them has been of a qualitative nature only. The substances which are oxidized are assumed

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

to be derivatives of catechol and are referred to in general as "tannins". However, Johnson and co-workers (1951) have described the isolation and identification of several tannins from the peach varieties J. H. Hale and Elberta. The tannin content of peaches has been found to depend on seasonal and growing conditions and the variety and maturity of the fruit (Blake 1941, 1942). Early maturing varieties are generally lower in tannin than later ones. The occurrence of the polyphenolase enzyme system in peaches has been reported by several workers and in some cases the activity of the enzyme in different varieties has been determined (Gaudagni *et al.* 1949; Grice *et al.* 1952). Grice and co-workers (1952) also reported that the activity of the peroxidase system was low in a number of varieties studied.

#### FACTORS AFFECTING THE RATE OF BROWNING OF PEACHES

Quantitative estimations of the rate of browning of peaches under rather extreme conditions were carried out on several varieties by Gaudagni and co-workers (1949). Peach tissue was blended in a Waring blender and the rate of browning was determined by measuring the change in colour produced and also from the loss in tannins in the substrate. A significant correlation was obtained between the loss of tannins and the increase in optical density of the suspension. Gaudagni observed that, provided sufficient substrate is present, the initial rate of oxidation is roughly proportional to the polyphenolase activity, and that the total amount of oxidation depends more on the initial tannin content of the peach than on the enzyme activity. These conclusions are supported by the earlier work of Kertesz (1933) on the variety Sunbeam. Although oxidizing enzyme systems were shown to be present in this variety, no browning occurred and it was shown that this was due to a deficiency of catechol tannins. A lowering of pH decreased the browning rate, and the storage temperature also affected the rate of oxidation (Gaudagni 1949). At storage temperatures of minus 10° F. and 0° F. there was little or no oxidation after 20 weeks, but significant amounts of tannins were oxidized at 20° F. even after one week's storage.

Grice, Brown and Burrell (1952), working along similar lines to Gaudagni, estimated the rate of browning, the polyphenolase activity, and the peroxidase activity of a number of peach varieties. The changes in carotenoid pigments during oxidative browning were small and varied with different varieties and were not affected by anti-oxidant treatments used in the experiments.

#### METHODS USED TO CONTROL ENZYMATIC BROWNING IN FROZEN PEACHES

Some control may be effected by selecting fruit with a low tannin content or low polyphenolase activity and at the correct maturity. However, absolute control can rarely be obtained in this way and consequently other methods are used. Methods of control may be classified as those depending on (i) the removal of oxygen, (ii) the inactivation of the polyphenolase enzyme systems, and (iii) the addition of anti-oxidants which maintain a reducing state in the fruit.

(i) *Removal of Oxygen.*—Atmospheric oxygen is essential for the enzymatic browning of peaches, and removal of the oxygen from the fruit tissues as well as from the atmosphere surrounding the fruit will prevent browning. This is generally effected by subjecting the fruit to a vacuum and breaking the vacuum with a syringe. If the product is

not vacuum-packed an anti-oxidant may be added to the syrup. However, vacuum-packing is not a very practicable method for large-scale production and is not used to any extent in the freezing of peaches.

(ii) *Variation of pH*.—Alteration of pH has a pronounced effect on polyphenolase activity and consequently has a corresponding effect on the rate of browning. In general, lowering the pH below the normal level for the fruit retards the rate of browning, and raising the pH accelerates the browning. Use is made of this fact in the handling of lye-peeled peaches. Cruess, Quin and Mrak (1935) reported that after lye-peeling the pH of the flesh of peaches rose from 4.0 to levels between 7.2 and 9.4. At the higher pH browning took place very rapidly. Dipping in dilute hydrochloric acid (0.25 per cent.) reduced this pH to 4.7 and retarded browning. If peach slices are kept wet with a solution at pH 3.5, or slightly lower, browning is well controlled (Woodroof 1940). However, packaging of peaches with added acid may have a detrimental effect on flavour, and in practice lowering of the pH is used to supplement other methods of control.

(iii) *Variation of Temperature*.—As with other enzyme systems, polyphenolase activity increases with a rise in temperature until the enzyme is heat-inactivated. Inactivation of enzymes by heat involves blanching the tissue until the enzyme has been inactivated throughout the fruit. If sufficient heat does not reach the centre of the piece of fruit the enzyme in this region will not be inactivated and browning will occur. The cooked flavour resulting from blanching is not desirable in frozen dessert-pack peaches and this method of control would find use only in the processing of pie-pack peaches.

(iv) *Use of Syrups*.—Frozen peaches are generally packed in a syrup. As well as acting as a sweetening agent, the syrup inhibits enzymatic browning to a certain extent, mainly by reducing the amount of oxygen coming into contact with the fruit. The use of invert syrups and their effect on frozen peaches were investigated by Joslyn (1949), who showed that the retention of the natural flavour, colour and texture of the product was influenced to a large extent by the degree of inversion of the syrup. For short storage periods of up to three months, differences were detected only in fruit packed in 90 per cent. invert syrup, but for longer storage periods syrups containing more than 50 per cent. invert sugar were not satisfactory. Fruit packed in syrups with the higher percentage of invert sugar showed greater losses of tannin and also greater losses of added ascorbic acid.

(v) *Use of Sulphur Dioxide*.—Sulphurous acid is widely used, particularly in dried fruits, to control enzymatic and non-enzymatic browning, and may be used successfully to control enzymatic browning in frozen peaches. The discoloration in frozen peaches may be controlled by dipping the fruit in a liquid containing 3000–4000 parts per million of sulphur dioxide, such as a solution of sodium bisulphite, sodium metabisulphite or sulphurous acid, for sufficient time to give a concentration of 50–75 parts per million of sulphur dioxide in the fruit (Joslyn and Hohl 1942). The concentration of sulphur dioxide necessary to control the browning can generally be detected when the fruit is eaten. This is undesirable in dessert-pack peaches; consequently it is best to use this process in the preparation of pie-packs, from which a considerable amount of the sulphur dioxide is expelled on cooking. The addition of sulphur dioxide as a glucose bisulphite addition-compound, as suggested by Cohee (1951), appears to be an improvement on other methods.

Cohee claims that fruit treated in this way has no off-flavour due to sulphur dioxide, and after thawing is superior in colour to samples to which ascorbic acid has been added before freezing. The compound is easily applied, and is said to be more economical than ascorbic acid.

(vi) *Addition of Anti-oxidants*.—The most common method used at present for the control of browning in frozen peaches is the addition of the anti-oxidant, l-ascorbic acid, suggested by Bauernfeind and Siemers (1945), and by Tressler and Dubois (1944). The l-ascorbic acid is generally added to the fruit with the syrup, the recommended proportion being 200–250 mg. per lb. pack (12 oz. fruit and 4 oz. syrup). The ascorbic acid maintains the fruit tissue in a reduced state, so that no oxidative browning can occur until all of the acid is oxidized. The addition of citric acid brings about little reduction in the amount of ascorbic acid needed, and does not prevent its oxidation. It does, however, have an adverse effect on the flavour of frozen peaches (Strachan and Moyls 1949). Du Bois and Colvin (1945) observed the effect of various peeling treatments, packaging methods and fluctuating storage temperatures on the loss of l-ascorbic acid in storage. Fluctuating storage temperatures caused the largest losses in l-ascorbic acid. Johnson and Gaudagni (1949) have described a method for the control of browning by dipping the fruit in a solution containing 1–2 per cent. sodium chloride, 0.4–0.5 per cent. l-ascorbic acid, and sodium bisulphite in sufficient amount to give a sulphur dioxide concentration of 300–1000 parts per million. The l-ascorbic acid and sulphur dioxide act as synergists, the fruit has a better flavour than when a sulphiting agent is used by itself, and the cost is less than treating with ascorbic acid only.

Other substances which act as anti-oxidants are thiourea (Denny 1943), dihydroxymaleic acid (Strachan and Moyls 1949), reductic acid and reductone (Tarr and Cooke 1950). Thiourea effectively inhibits browning but not as well as sulphur dioxide; it affects the flavour adversely and is not used because of its probable toxicity. Dihydroxymaleic acid will inhibit enzymatic browning but the compound is rather unstable and is not as effective as l-ascorbic acid. Reductone and reductic acid, which are derived from sugars and are similar in structure to ascorbic acid, will also reduce browning in frozen peaches but not as effectively as l-ascorbic acid.

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# Further Aspects of the Preparation and Storage of Sugared Fruit\*

By

D. McBEAN†

## INTRODUCTION

A previous report, issued by the Dried Fruits Processing Committee (1950), on the preparation of sugared fruit gave details of the optimum maturity for raw material and of the major steps in processing. The present paper, covering experiments in the two seasons since, deals with a number of additional processing details and with the main factors affecting the storage life of the material.

## RE-USE OF SYRUPS

This subject was mentioned briefly in the above report since it was realized that it was one of the most important factors in the economic production of sugared fruit. A number of experiments have been done to determine the possibility of using syrups repeatedly in the factory.

(i) *Syrup Concentration*.—After fruit had been steeped in syrup for 16 hours, the concentration of sugar fell to 45–50° Brix. Initially, this syrup was concentrated for re-use by the addition of sucrose, or a mixture of sucrose and concentrated invert syrup, followed by gentle heating to dissolve the solid sugar. This method was effective in the laboratory but was rather time-consuming. The reducing sugar content of the syrup could be controlled so that it did not rise to the high levels at which a jam-like dehydrated product formed.

Used syrup was also concentrated by boiling for a short time (5–10 minutes) in an open cooker. Progress of concentration was followed by using a refractometer. Excessive boiling at this stage could result in considerable inversion of cane sugar on account of the presence of acid leached from the fruit. The highest acidity value in these trials was 0.6 per cent. Boiling a concentrated sucrose syrup for 30 minutes with 0.4 per cent. citric acid will result in complete inversion. A vacuum concentrator could also be used for this stage of the process.

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\* Issued at the request of the Dried Fruits Processing Committee and based on work at the C.S.I.R.O., Division of Food Preservation and Transport, Homebush, N.S.W. The Dried Fruits Committee works under the aegis of C.S.I.R.O. and has the following membership:

A. G. Strickland, Department of Agriculture, Adelaide, S. Aust. (Chairman).  
 W. R. Jewell, State Laboratories, Melbourne, Vic.  
 Dr. J. R. Vickery, C.S.I.R.O. Division of Food Preservation and Transport, Homebush, N.S.W.  
 D. G. Quinn, Department of Agriculture, Rutherglen, Vic.  
 F. H. Colbey, Commonwealth Department of Commerce and Agriculture, Adelaide, S. Aust.  
 F. Penman, C.S.I.R.O. Commonwealth Research Station, Merbein, Vic.  
 J. D. Bryden, Department of Agriculture, Sydney, N.S.W.  
 B. G. Coombe, Department of Agriculture, Adelaide, S. Aust. (Secretary).

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

With concentration by boiling, reducing sugar values as high as 13 per cent. were obtained but usually they were below 10 per cent., which is considered satisfactory for good quality.

The acidity level of the re-used syrup tended to become steady at above 0.4 per cent.

(ii) *Sulphur Dioxide Concentration*.—The above report described how sulphur dioxide, necessary for good quality in the dehydrated product, was incorporated in the fruit by the addition of potassium metabisulphite to the syrup. After the addition of sugar, it was necessary to estimate the sulphur dioxide remaining in the syrup in order to return the level to 0.15–0.25 per cent. (w/w), which was found suitable for giving a satisfactory initial value. When the syrup was boiled, most of the sulphur dioxide was driven off: in these trials approximately 10 per cent. of the initial concentration remained.

With 12 re-used syrups, in which the initial concentration of potassium metabisulphite was 0.2 per cent., analyses for sulphur dioxide showed a range of 967–1160 parts per million. The sulphur dioxide content of the dehydrated samples prepared after soaking in these syrups fell within the range 525–622 parts per million. This indicated better control than that obtained on sulphuring by exposure to fumes from burning sulphur.

(iii) *Tasting Tests*.—No samples prepared from re-used syrups have been stored, but immediately after preparation no quality differences were detected by a panel of experienced judges. In these tests syrups had been re-used up to six times.

#### TEMPERATURE OF STEEPING SYRUP

The temperature of the syrup in which fruit was immersed had a significant effect upon the quality of the dried material and on the yield. Three sets of conditions were investigated: (1) syrup at 90° C. on introduction of fruit, cooling to room temperature slowly; (2) same as (1), except for initial temperature, which was 70° C.; (3) room temperature throughout (20–25° C.). Flavour and colour were slightly better for hot-syrup dips than for the cold-syrup treatment. This was probably due to the higher amount of sugar present in the hot-dipped material.

In one experiment with freestone peaches, 2.8 lb. of fresh fruit were required to produce 1 lb. of dried material with cold soaking. With 70° C. soaking, 2.65 lb. were required, and at 90° C. 2.55 lb. were required.

#### MULTIPLE SYRUPING

A single immersion in syrup for 32 hours was compared with a primary immersion for 16 hours followed by a secondary immersion in freshly made syrup for a further 16 hours. There was no difference in any quality factor, but the yield was increased slightly by the double syruping. Drying ratios were 2.9 and 2.45 respectively. From an economic standpoint the troublesome handling for double syruping would offset any gain in yield over the single immersion.

#### DRYING TEMPERATURE

The most usual drying temperatures used in these trials were 130–140° F.; however, 160° F. has been used with no decrease in quality immediately after drying. Material from this trial was in storage at the time of writing. The drying time for sliced freestone peaches was 12 hours at 130° F. and 8½ hours at 160° F.



## FACTORS AFFECTING STORAGE LIFE OF SUGARED FRUITS

The aim of the storage experiments on sugared fruits has been to determine the conditions necessary to give a product which is still acceptable 12 months after preparation. Storage temperatures employed were  $-20^{\circ}\text{C}$ . (used for a control sample in testing tests),  $20^{\circ}\text{C}$ . ( $68^{\circ}\text{F}$ .), and  $25^{\circ}\text{C}$ . ( $77^{\circ}\text{F}$ .). In all storage trials, the difference in quality between  $20^{\circ}\text{C}$ . and  $25^{\circ}\text{C}$ . was much greater than that between  $-20^{\circ}\text{C}$ . and  $20^{\circ}\text{C}$ . This showed that care should be taken to ensure that material was not held at high temperatures for long periods. Storage times used were 6, 12 and 18 months.

(i) *Moisture Content*.—The rate of deterioration of sugared fruit increased slightly with increasing moisture content over the range 15–25 per cent. However, an overriding consideration is that the moisture content must be 23–25 per cent. if the product is to have an acceptable texture.

(ii) *Composition of Steeping Syrup*.—A high level of reducing sugar in the steeping syrup resulted in a jam-like product initially. In addition, in the majority of storage trials the rates of deterioration of flavour and colour in storage were found to increase with increasing levels of reducing sugar.

All data on initial quality and storage suggested that the reducing sugar content of the steeping syrup should not exceed 10 per cent.

(iii) *Temperature of Steeping Syrup*.—Samples soaked in syrup at  $90^{\circ}\text{C}$ . tended to store better than those soaked at  $70^{\circ}\text{C}$ . The hot-syruped samples stored slightly better than those soaked at room temperature. Again this may be attributable to slight differences in sugar content of the samples.

(iv) *Method of Sulphuring*.—In one experiment with apricots, sulphuring by the addition of potassium metabisulphite to the syrup was compared with sulphuring by exposure to fumes from burning sulphur. Although actual differences were small, the "addition" samples consistently scored better than "exposure" material. The loss of sulphur dioxide in storage was not affected by the method of sulphuring.

(v) *Sulphur Dioxide Content*.—This was undoubtedly the most important factor determining the storage life of sugared fruit. Levels as low as 100 parts per million were tried, in line with British import regulations. It was found that not only was storage life of such samples very short, but also initial quality was lower than desired. The highest level used was 1250 parts per million. While this ensures a storage life of 12 months at  $25^{\circ}\text{C}$ ., some individuals objected to the "sulphite" flavour. Other tasters did not find the sulphite objectionable. A series of trials has shown, however, that a level of 500 parts per million ensured a storage life of 12 months at  $20^{\circ}\text{C}$ . and possibly 12 months at  $25^{\circ}\text{C}$ .

The loss of sulphur dioxide in storage increased with moisture content, time, and temperature.

(vi) *Addition of Ascorbic Acid to Syrup*.—While improving colour scores initially, the addition of ascorbic acid to sugared peaches produced severe browning during storage. Levels of acid added to the syrup were 0.01 per cent. and 0.1 per cent. respectively. Darkening was more severe at the higher level.

## REFERENCE

DRIED FRUITS PROCESSING COMMITTEE (1950).—The Preparation of Sugared Fruit. *Food Pres. Quart.* 10: 64.

# Control of Mould Wastage in Citrus Fruit

By

J. K. LONG\*

The Citrus Wastage Research Laboratory at Gosford, New South Wales, which is controlled jointly by the C.S.I.R.O. Division of Food Preservation and the New South Wales Department of Agriculture, refers in its latest report to progress in methods for controlling mould wastage in citrus fruit.

## NEW DIP TREATMENT

A new dip treatment for control of green mould wastage in oranges shows promise of being more successful than the orthodox method using borax, boric acid and a wax solution, described by Hall and Long (1950).

Initial trials with the new dip, which consists of a mixture of sodium orthophenylphenate (also known in U.S.A. as "Dowicide A") and hexamine, have been so encouraging that full scale trials are being carried out in the 1953 citrus season.

## DIPHENYL WRAPS

Tests so far conducted with wraps impregnated with the chemical diphenyl have shown them to be as effective as the borax dip treatment in reducing green mould wastage and more effective in reducing stem-end rots. They are likely to be especially useful on export fruit, but final judgment on them cannot be made until further trials have been carried out. In the experiments to date, wraps from both Israel and the U.S.A. have been tried, but the wraps could be made in Australia if necessary.

For the present, care should be exercised in using the wraps commercially. The diphenyl imparts a taint to the fruit which, fortunately, is much less marked in the flesh and juice than in the skin. Overseas experience indicates that this is not a serious difficulty as the taint is quickly lost once the fruit has been taken out of the box and unwrapped. The Gosford investigators nevertheless feel that more experiments are needed to assess the importance of the tainting under commercial conditions.

## CLIPPING VERSUS PULLING

When the harvested oranges were not processed to control decay, clipping consistently resulted in less green mould wastage than did pulling. However, when an effective decay control treatment such as the borax dip was used the reduction of mould wastage was so great as to eliminate the difference due to the method of picking. Consequently the additional expense of clipping can be avoided by the adoption of a proven decay control process.

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\* Fruit Research Officer, New South Wales Department of Agriculture, stationed at the Citrus Wastage Research Laboratory, Gosford.

### MOULD SPORE LOADS ON FRUIT

The work in progress on the effect of the numbers of spores of green mould on the surface of oranges has already shown that the higher the spore load on the orange, the higher the subsequent wastage. When it is realized that the skin of a single orange coming from the orchard can carry 50,000 or more mould spores, each one capable of infecting an orange and causing it to rot, the necessity for strict care in handling and in packing-shed hygiene is obvious. Where a "wet" process is used, the build-up in population of mould spores in the washing tank is enormous and consequently, the tank and equipment must be thoroughly and regularly cleaned and disinfected. In conjunction with an efficient detergent bath, the use of transverse rotating scrubbing brushes with ample overhead sprays of clean hot water has been shown to reduce the "natural" spore load on Washington Navel oranges from 56,000 spores per orange to about 900 spores per orange, and subsequent wastage (after 2½ weeks' common storage) from 8.3 per cent. to 2.4 per cent. It also follows that all equipment, especially picking bags and field cases, should be regularly cleaned and sterilized.

### LEMON STORAGE

The lemon storage investigations, which have been in progress for several seasons, have shown that coastal main crop lemons can be kept in good condition in orchard shed storage for as long as six months. Fruit harvested in June at the light green to silver stage of maturity and carefully clipped from healthy vigorous trees has been kept for six months with less than 5 per cent. loss and a 99 per cent. retention of fresh green colour in the buttons. The effective treatment consists of dipping the fruit immediately after picking in a solution of 500 parts per million of 2,4-D plus 0.25 per cent. of the proprietary fungicide "Shirlan W.S." Dipping in 2,4-D alone reduced wastage due to Stem-end Rot (the main type in carefully handled shed-stored lemons) from 50 per cent. to 5 per cent. (provided that the trees had received the routine Bordeaux "scab control" field spray at half petal-fall), with 85 per cent. of the buttons retaining their green colour after six months' storage. Initial field trials have also indicated that some measure of control of Stem-end Rot in storage can be obtained by applying Bordeaux sprays between February and April.

### REFERENCE

- HALL, E. G., and LONG, J. K. (1950).—Citrus wastage investigations. *Agric. Gaz. N.S.W.* 61: 631, and *Food Pres. Quart.* 10: 48.

# Waste Disposal in Canneries\*

By

F. E. ATKINSON† AND C. C. STRACHAN‡

The mechanical handling of waste from canneries varies from plant to plant, depending on factors such as: (a) elevation of plant in relation to surrounding terrain, (b) proximity of plant to city sewers, and (c) location of the plant in an agricultural area requiring irrigation.

## DESCRIPTION OF SYSTEM

Fig. 1 depicts a scheme whereby all water and water-borne solids drain into a tank about 4 ft. square and 7 ft. deep which is equipped with a non-clog vertical centrifugal sewage pump (A). This has a 3-in. suction and is directly connected to an 1800 r.p.m. motor. The float on the float switch is adjusted so that the pump suction is always flooded. A 4-in. pipe (B) with bends (not elbows) carries the solids and liquid from this tank to a separating screen (C). This may be either a round revolving screen or a set of vibrating screens. If the latter are used, a  $\frac{1}{4}$ -in. mesh screen on top and an  $\frac{1}{8}$ -in. screen on the bottom will be satisfactory for many products. The solid discharge from this screen falls directly into a trailer tractor wagon (E) or into a dump truck with an air-tight box. This material is hauled away from the factory to agricultural land, where it is spread. The liquid from the separating screen is accumulated in a tank (D), 4 ft. square and  $3\frac{1}{2}$  ft. high, that acts as a reservoir so that an even flow is delivered to the settling tank (G). The size of the outlet from the reservoir to the settling tanks will depend upon the size of the factory, a 2-in. hole being satisfactory for a small plant.‡

The purpose of the settling tank (Fig. 2) is to remove the finer solids from the water. The dimensions suggested are 30 ft. long, 3 ft. wide and 2 ft. deep. If the entry and exit tanks are included the total length is 36 ft.

Four cement baffles, 16-in. high, divide the tank into four settling basins and a screening section. Planks 2-in. by 12-in. are inserted in each of the first four sections and protrude 4-in. below the top of the baffles. These planks force the water to follow an over-and-under course so that short circuiting cannot result. The final griddle to ensure that no large solids go into the drain is made of  $\frac{1}{2}$ -in. rod with 1-in. spaces between. It is set on about a 30° angle, and is covered with screening. The tanks are built in pairs so that one may be cleaned while the other is in operation. The water emerging from these tanks should be sufficiently clear to enter the sewer, or it may be used for irrigation if the

\* Reproduced from the British Columbia Processors' Handbook, by kind permission of the Superintendent, Department of Agriculture Experimental Station, Summerland, B.C., Canada.

† Department of Agriculture Experimental Station, B.C., Canada.

‡ The process outlined so far is essentially that of Barkwills Limited of West Summerland, B.C., but the settling tanks about to be described were designed by Mr. E. T. Buffum of Bulmans Limited, Vernon, B.C., Canada.

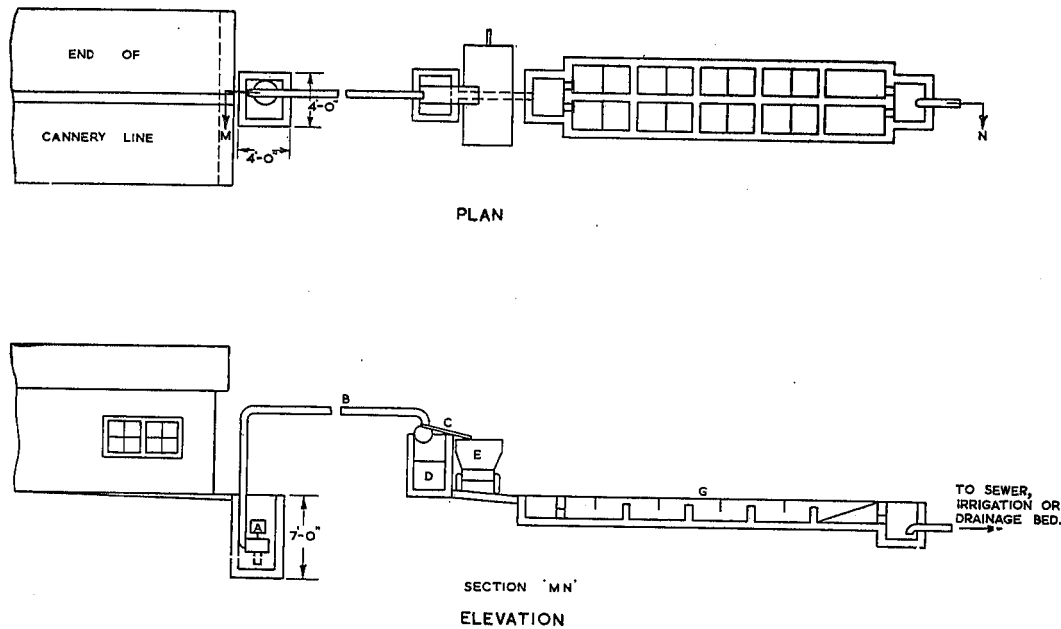


Fig. 1.—Schematic Drawing of Waste Disposal System for Canneries.

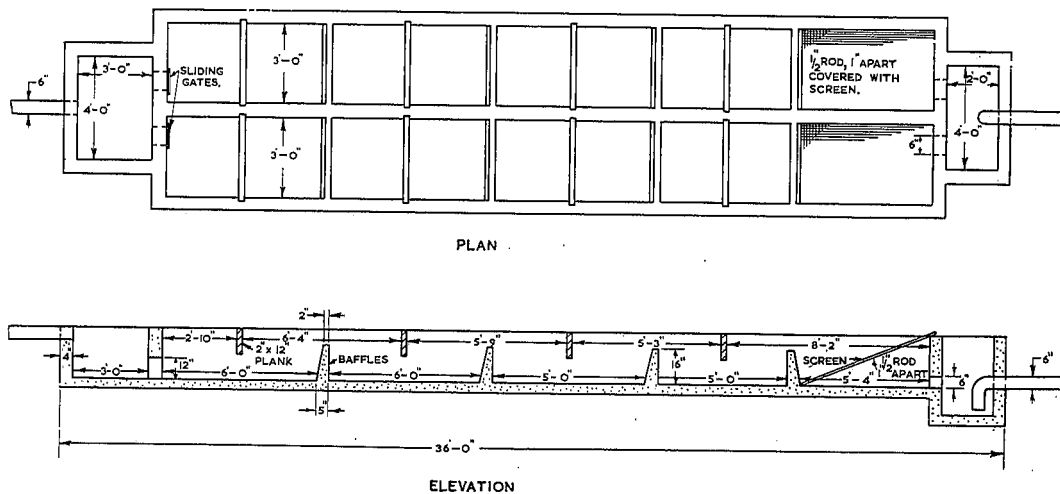


Fig. 2.—Settling Tanks for Waste from Canneries.

plant is located in an agricultural area. In areas where there is considerable sprinkler irrigation being carried on near the cannery, it may be wise for the cannery to pay the cost of joining several growers' mains together so there is always an outlet for the cannery waste water. In cases where the waste water flows into a large lake where the biological oxygen demand is not a factor but where finely divided pulp is not wanted, it may be necessary to pass the water from the settling tank through a sand filter.

#### CLEANING SETTLING TANK

One of the most economical and least unpleasant ways of cleaning the settling tank is to use a portable vacuum pump and an air-tight steel tank mounted either on a truck or tractor-trailer. The pump is driven either by a gas engine or electric power. With this equipment an air-tight steel tank is required which is sufficiently strong to stand a fairly high vacuum. This tank is equipped with a 3-in. suction hose which is used for loading and unloading the tank. In operation, a vacuum is drawn on the steel tank and the suction hose inserted into the settling tank. The solid material, with some liquid, is drawn into the portable tank and the valve closed. When the waste material has been hauled to the point for disposal, a by-pass on the vacuum pump is used to develop a pressure in the portable storage tank to assist in emptying it.

### Recovery of Wastes in Pear Canning

Residues from the peeling and coring machines in a pear cannery may amount to 40 per cent. of raw fruit intake. In the Goulburn Valley, Victoria, the pear waste approximates 100 tons daily during the season. This is material for which canners have paid the fresh fruit price and which in addition presents a problem in waste disposal. For years profitable outlets for this potentially useful product have been sought.

The major engineering problem in the utilization of pear wastes has been the difficulty in separating the soft slimy mass into liquid and solid fractions. Existing types of screens and presses are unsuitable for handling pear pulp.

The Western Regional Laboratory of the United States Department of Agriculture, Bureau of Agricultural and Industrial Chemistry have now developed a double-drum press which recovers 75 to 80 per cent. of juice from the waste material and leaves a filter cake that can be shredded and dried without difficulty. This press has a capacity of at least six tons of pear waste an hour. Its principles, construction and performance are described by text, diagrams and photographs in their publication AIC-343, October 1952, and also in the following articles in journals:

*Food Eng.*, **24** (2): 82, 136 (1952).

*Western Canner*, **44** (13): 19 (1952).

*Canner*, **116** (2): 12 (1953).

*Chem. Engin.*, **59**: 234 (1952).

*Food Processing*, **13** (5): 14 (1952).

*Industrial Laboratories*, **3** (5): 82 (1952).

It is considered that the new press has considerable usefulness beyond the immediate problem of pear waste recovery in the general field of extraction of juices from fruit and vegetable products.

## Protective Wrapping of Frozen Skinned Rabbits\*

By

J. R. VICKERY†

Skinned rabbits are more liable to the onset of severe freezer-burn during storage than almost any other form of carcass meat. The onset of severe freezer-burn has often caused a depreciation in value of the rabbits in overseas markets. Skinned rabbits, unlike most other carcass meats, have little or no natural protective covering in the form of surface fatty tissues. They are, therefore, very liable to severe desiccation of the surface meat, leading to freezer-burn.

The onset of freezer-burn in skinned rabbits can be prevented, or at least greatly reduced, by the use of protective wrapping which markedly reduces the rate of loss of moisture from the frozen carcasses. There are two forms in which this wrapping may be applied.

Firstly, if a high quality trade such as to U.S.A. calls for individual wrapping of carcasses, each carcass may be placed in a bag made of a high-grade moisture-proof film. Suitable films for this purpose include MSAT grade "Cellophane", F.F. grade "Pliofilm" or "Cry-o-Rap". A case liner of kraft or parchment paper will be used in addition for mechanical protection. Naturally, this form of wrapping is expensive and the costs are likely to be recouped only in a high-price market.

Secondly, the rabbits may be placed in the usual way in a solid block in the case, but a high-grade case liner used in place of the usual parchment or grease-proof paper liner. It is not easy, however, to find at the present time a suitable high-grade case-lining material having the following characteristics:

- (a) good resistance, at low temperatures, to tearing and perforation,
- (b) relatively high resistance to the passage of water vapour,
- (c) reasonable cost.

Most waxed papers will not be good enough but they will, at least, be better than grease-proof or parchment papers which afford practically no restriction to the passage of water-vapour. It is likely that the most suitable case liners will be found among laminated materials, in which kraft paper is laminated to a thin film having high resistance to the transfer of water vapour. The kraft paper has good mechanical properties, consequently the thickness of the costly moisture-resistant film can be reduced, giving at a reasonable price a material with the desirable characteristics. Such laminations should shortly be available from Australian manufacturers. Typical laminated materials will be

\* Notes presented to the Commonwealth Cold Storage Association Conference, Adelaide, South Australia, June 1953.

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



kraft-polyethylene film or kraft-MST "Cellophane". It is suggested that inquiries about these laminated materials should be directed in the first instance to Australian Paper Manufacturers Ltd., Sydney and Melbourne.

The Division of Food Preservation has no data on the extent to which the rate of freezing is reduced by the use of these wrapping materials. However, in the case of individually wrapped carcasses, a distinct but unimportant decrease in the rate of freezing will probably result. For case liners, the laminated material should not affect the rate of freezing more than ordinary liners such as grease-proof paper.

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### Lament for Muffins

*Though the plaint below, reprinted with the kind permission of "Food Manufacture", gives words to the grief of our kinsmen in England, it may be also that the feelings of Australian muffin lovers will melt on reading it, and they too will feel the familiar lump in the throat.*

In asking where the muffin has gone nowadays, Lord Asquith has certainly set a teaser to many muffin enthusiasts, even though His Lordship was deluged with samples after a one-line letter in *The Times*. Did the muffin go out when butter rationing came in? Or is it that it is recognized as an aid to indigestion, as many regard it?

The first query does not take us far, since the crumpet, with its perforations positively soaking up melted butter, is still at large in the shops though not hawked in the streets. "Crumpets is not wholesome, Sir", says a doctor in Sam Weller's days. Lord Asquith supports this view of a sorry substitute for a muffin in defining the crumpet as "that limp, lardaceous, pockmarked parody of the muffin". As the muffin has vanished, gone too (except in one or two rural areas) is the muffin-bell sounded to give, like the dinner gong to Pavlov's dogs, a pleasurable flow of anticipatory saliva and gastric juices on hearing it in the street.

W. S. Gilbert, in *The Sorcerer*, saluted the muffin, yet little or no literary references remain to support its claims for survival. The only example, and a derogatory one at that, came when George Bernard Shaw used it as simile for stodginess in *Man and Superman*: "Mary Ann, and at the end of a week you'll find no more inspiration in her than in a plate of muffins". Even in coming to present-day definitions, as in the O.E.D., we have our doubts on the muffin's value for older folk with inferior digestive powers. "A light, flat, circular, spongy cake eaten toasted and buttered at breakfast or tea", runs the description. But so many of the muffins we used to consume were anything but "light and spongy".

## Answers to Inquiries

### MEAT EXTRACT

*Question :* How is meat extract prepared ?

*Answer :* The method commonly used to prepare meat extract in most meatworks in South America and Australia is set out below.

#### *Preliminary Cooking*

The fresh meat, boned and dressed, is packed in steel baskets and immersed in hot water in scalding-tanks for about 20 minutes. This process removes the most soluble and desirable extractives amounting to  $\frac{1}{2}$ –1 per cent. of the meat, and partially cooks the meat in readiness for pickling and canning. Additional lots of meat are scalded in the liquor until the concentration of the dissolved solids is brought up to a level at which evaporation may be commenced. From time to time the liquor is skimmed to remove fat and other scum. (It should be explained that liquors obtained on cooking pickled meat are not satisfactory for making meat extract, since they become saturated with salt long before reaching the pasty stage.)

#### *Evaporation*

The soup liquors are filtered through filter-cloth bags, preferably through a filter press, and fed to some form of vacuum evaporator, usually the triple effect type. In this type of evaporator the first stage is run at about five pounds steam pressure and seven inches vacuum, the second stage at about 12 inches vacuum, and the third at about 20 inches. The result of this treatment is to reduce the moisture from about 95 to 35 per cent. The remainder of the concentration needed to reduce the mixture to the final figure of about 18 per cent. is performed in finishing pans of the open shallow steam-jacketed type, preferably with agitators. The rate of movement of the agitators is usually about 12 rotations per minute. In some Australian processes all of the evaporation is carried out in open vessels without vacuum—the first stage in cookers with exposed steam coils in the bottom, and the final stage in a steam-jacketed vessel. The transfer from one vessel to the next is usually by gravity flow.

The evaporation under vacuum causes very little alteration in the character of the extractives, but the greater heat and access to oxygen in the finishing pans brings about quite important changes in the composition of the extract. The absence of heating causes the slowly evaporated product to be light in colour, spongy in texture, and weak in meaty flavour. Also, the solubility of such a product is low. On the other hand, excessive heating with free access to air gives rise to objectionable features by bringing about many complex changes in the nature of the extract. For example, protein degradation products may be broken down to amino acids or even ammonia, causing unpleasant flavours. Moreover, the total creatine content may be materially reduced by over-heating at this stage, whereas normally the creatine would be converted to creatinine. This conversion of creatine to creatinine is a useful index

of the rate of heating in the finishing pans, other things being equal. In some countries a standard of six per cent. has been adopted as a proper lower limit for creatine and creatinine. The texture of extracts may be improved by homogenization. Finishing continues until the moisture content of the extract reaches a level to give the desired consistency. A quick density method for determination of moisture content of meat extract has been described by Riddle (1945). Copies of his paper are available from the Librarian, C.S.I.R.O., Division of Food Preservation.

Assuming that both the early stages of the process and the finishing have been properly carried out, the product should be a reddish brown paste with a strong meaty odour and taste. It is usually run off into 56 lb. containers, and sealed hot.

#### *Yield and Quality of Extract*

The yield of extract ranges from  $1\frac{1}{2}$ –2 per cent., that is  $1\frac{1}{2}$ –2 lb. from 100 lb. of meat. The best grades of extract are usually obtained from beef muscle. Lower grades containing less creatine and creatinine are obtained if other organs are included with the meat to be extracted. An extract differing somewhat in texture and flavour from that of beef can be prepared from mutton.

#### *Equipment*

The equipment required will depend on whether the preliminary evaporation is to be done in open vessels or under vacuum. It may be feasible to use one-stage vacuum-heating to reduce the moisture content to about 50 per cent. before passing on to the final open-pan evaporation. Although some factories use filter presses for filtering the soup liquors, others use simple cloth filter bags without any pressing.

#### *Reference*

RIDDLE, A. R. (1945).—*J. Coun. Sci. Industr. Res. Aust.* **18**: 153–159.

## **Food Technology Diploma Course**

The Principal, Hawkesbury Agricultural College, Richmond, N.S.W., invites entries for the diploma course in Food Technology at the College.

This is a specialized course of two years duration designed to train students for managerial and technological positions in fruit and vegetable processing factories.

Applications for the course, which in 1954 will commence on 3rd February, should be made to the Principal as soon as possible.

Applicants must—

- (1) be not less than 17 years of age on 3rd February, 1954 ;
- (2) possess the Intermediate Certificate issued by the N.S.W. Department of Education or its equivalent ;
- (3) possess a satisfactory testimonial as to character and evidence as to aptitude, fitness and eligibility for the course from his last teacher or employer ;
- (4) furnish an approved medical certificate from a duly qualified medical practitioner.

## News from the Division of Food Preservation

### THE WORK OF THE BIOCHEMISTRY SECTION

The Biochemistry Section, which is located at the Divisional Headquarters at Homebush, has a staff of two research officers and two technical assistants. It is carrying out investigations on fundamental problems in the preservation of fruit and vegetables.

One investigation is concerned with the reactions responsible for the loss of ascorbic acid (vitamin C) during processing and storage. The reactions are (i) the oxidation of ascorbic acid to dehydro-ascorbic acid, (ii) the decomposition of dehydro-ascorbic acid, and (iii) the anaerobic decomposition of ascorbic acid. The influence of a number of factors on these reactions has been investigated, but the last two reactions are complex and some of the decomposition products still require identification and study.

A second investigation is on the organic volatile products of whole apples. There is evidence that some of these volatiles are concerned in the storage disorder, superficial scald. A number of the volatiles have been identified. One or two of these appear to cause slight scald, but the natural volatiles directly concerned probably still await identification.

The natural waxy coating of the apple is the subject of the third investigation. This coating controls the resistance of the apple skin to gas exchange and hence the composition of the internal atmosphere of the fruit, the rate of ripening, and the storage life. The natural coating has been separated into four main fractions, each of which has been studied. The oil fraction is of particular interest, for it increases considerably during storage. A thorough chemical study is being made of this fraction with a view to identifying the individual constituents.

### BACON AND HAM CURING CONFERENCE

A conference on technical problems of the curing of ham and bacon was held in Melbourne on July 29th, 1953. It was attended by representatives from a large number of bacon curing establishments, from Commonwealth and State Government departments and from the Division of Food Preservation, C.S.I.R.O. Several papers outlining recent scientific and technological advances in the field were presented, and discussions took place on several important technical problems facing Australian curers. A committee was elected to report to a later conference on several matters, including technical education on curing, and whether a programme of research work should be commenced in Australia.

### PERSONAL

Mr. I. J. Tinsley, a Research Officer of the Division of Food Preservation and Transport, left Australia on 24th August, 1953, to take up a graduate assistantship in the Department of Food Technology of the Oregon State College, Corvallis, U.S.A.

At Homebush Mr. Tinsley was engaged on research into the freezing of fruit and vegetables. At Corvallis he will study for the M.S. degree and will carry out some research in Food Technology.

The State of Oregon is noted for its production of hazel-nuts, or filberts as they are called there, and Mr. Tinsley will most likely devote some of his time to working on the problems involved in peeling these nuts.

Mr. Tinsley expects to be absent from Australia for about two years.

#### PUBLICATIONS BY STAFF

- (1) The Climacteric Rise in Respiration of Fruit. By Judith A. Pearson and R. N. Robertson (1952).—*Aust. J. Sci.* 15 : 99-100.

Some varieties of fruits show a well marked rise in respiration rate at a certain stage of their development, after active growth has ceased. Earlier papers from the Laboratory discussed this climacteric rise in respiration in Granny Smith apples developing on the tree. This paper brings evidence in support of the hypothesis that, at a critical stage in development the increasing demands of protein synthesis in larger cells may result in a greater concentration of free phosphate acceptors, which, by taking phosphates more rapidly from intermediates in respiration, increase the respiration rate.

- (2) The Physiology of Growth in Apple Fruits. IV. Seasonal Variation in Cell Size, Nitrogen Metabolism and Respiration in Developing Granny Smith Apple Fruits. By Judith A. Pearson and R. N. Robertson (1953).—*Aust. J. Biol. Sci.* 6 : 1-20.

Results of investigation of cell size, fruit size, nitrogen metabolism and respiration rate over three successive seasons confirm the main conclusions of earlier papers in this series. Fruit left on the trees for a period beyond normal commercial maturity showed a very large increase in soluble nitrogen with only slight increase in protein nitrogen. The relation of the nitrogen and organic acid metabolism to the climacteric rise in respiration is discussed.

- (3) The Survival of Airborne Micro-organisms. I. Experiments near 0° C. with Some Psychrophilic Bacteria. By A. D. Brown (1953).—*Aust. J. Biol. Sci.* 6 : 463-9.

This paper submits results of experiments on the behaviour of some bacteria carried in the air in a cold room at 0° C. Three bacterial genera (*Achromobacter*, *Pseudomonas* and *Micrococcus*) which grow on chilled beef and cause spoilage were used, and their rate of death was studied at relative humidities between 45 and 90 per cent. For all three organisms the rates of death were least and of a similar magnitude at 65-70 per cent. relative humidity.

- (4) The Survival of Airborne Micro-organisms. II. Experiments with *Escherichia coli* near 0° C. By A. D. Brown (1953).—*Aust. J. Biol. Sci.* 6 : 463-9.

The humidity/death rate relationships of two types of airborne *Escherichia coli* were studied at approximately 0.5° C. over the range 45-100 per cent. relative humidity. Support was obtained for previous findings with psychrophilic bacteria of minimal death rates at about 70 per cent. relative humidity.

Evidence suggests that, after spraying into the air from an aqueous suspension, bacterial cells come rapidly into equilibrium with the atmosphere, and that measured death rates are associated with these equilibrium conditions.

At least two separate lethal mechanisms operating near 50 per cent. and 90 per cent. relative humidity respectively seem to be potentially available for the destruction of airborne bacteria. For *Escherichia coli*, at least, the lower-humidity mechanism is probably a direct water activity effect. The high-humidity mechanism seems to be neither a water activity effect nor a "cold shock" reaction.

Death of *Escherichia coli* at low humidities was not affected by the age of the cells, but at high humidities death was most rapid with young cultures.

Differences in behaviour at high humidities were observed between rough and smooth, and between aerated and anaerobic cultures.

- (5) The Mitochondrial Membrane. By J. L. Farrant (C.S.I.R.O., Division of Industrial Chemistry), R. N. Robertson and M. J. Wilkins (1953).—*Nature*, **171**: 401-2.

For several years there has been a controversy between cytologists as to whether mitochondria are compact gels, or are bounded by a morphological membrane. This letter includes two fine electron micrographs of mitochondria from red beet cells, one of a preparation in 30 per cent. sucrose and the other in 0.45 per cent. potassium chloride solution. The mitochondria have the typical appearance of inflated and shrunken membranes in the respective preparations.

Copies of the papers mentioned above are available from the Librarian, Division of Food Preservation, Private Bag, Homebush Post Office. Telephone UM 8431.

## Effects of Delay in the Storage of Pears

Delaying the storage of pears picked later than the optimum stage can greatly reduce their storage life, particularly if temperatures are high. This is especially true of the sensitive Williams variety.

Pear growers are advised to handle their fruit for cool storage promptly, in the manner which both research and experience have shown to be the safe way.

Although investigations carried out at Homebush by the C.S.I.R.O. Division of Food Preservation and the New South Wales Department of Agriculture have shown that under special conditions the cool storage of pears can be delayed after picking for as long as three days in the case of Williams pears and longer for the Packham's Triumph variety, these findings cannot yet be translated into commercial practice.

The recommendation still stands that pears should be placed in cool storage as soon as possible after picking and cooled down rapidly.

The experimental results referred to above, although statistically significant, were obtained only with fruit *carefully picked at optimum maturity* at the Bathurst Experiment Farm, New South Wales. Furthermore, the fruit was held during the delay period under controlled conditions at a constant temperature of 68° F. Under commercial conditions no grower can harvest all his fruit at optimum maturity and temperatures at picking time may often be much higher than 68° F.

## Tin in Canned Foods

The Minister of Food in the United Kingdom has approved of the publication of a report, which has been presented to the Food Standards Committee by its Metallic Contamination Sub-Committee, on the presence of traces of tin in canned foods.

The main points of the report are as follows :

1. " Tin has no known physiological function and its presence in human food is almost entirely due to the use of tin as foil for the wrapping of food, and more particularly to the use of tinplate for canning.

2. The corrosion of tin plate in food containers depends upon a number of factors including the air in the head-space of the can, acidity (pH) of the contents, and the presence or absence of iron salts.

3. The colour of red and purple fruits other than tomatoes may be affected by tin plate, and blue or violet lakes may be formed by the combination of tin with the colouring matter in the fruit. A very small amount of tin may cause haze in beer.

4. In 1908 Buchanan and Schryver found that even with the canning methods in force at that time concentrations of tin in canned foods above 2 grains per pound (286 parts per million) were unusual and unnecessary. This limit has been generally accepted as appropriate.

5. In 1937 Adam and Horner, basing their results on analyses carried out over a period of ten years, found that where lacquered cans were used the tin content of the canned products seldom exceeded 40 parts per million.

In plain cans rather more tin may be taken up, particularly by asparagus, rhubarb, fish in oil and foods which have been treated with sulphur dioxide or contain salt. Rarely, however, is the amount substantially higher than 2 grains per pound (286 parts per million).

6. In general the pick-up of tin is much reduced by the use of lacquered tins but plain cans are preferred for some fruits and vegetables ; in particular " hydrogen swell " is less likely to occur when acid foods are stored in plain cans than in lacquered cans.

7. Excessive tin in canned meats has been associated with a long storage period. The tin content of canned foods may rise if the can is opened and the food remains in the can exposed to the air. Cheese wrapped in tin foil was at one time found to contain very large quantities of tin and to suffer some discoloration, but this situation is not likely to arise in future in view of the specification issued by the British Standards Institution in 1948, which requires that the tinfoil should have a protective coating on one or both sides of the foil.

8. So far as is known the informal limit of 2 grains per pound (286 parts per million) of tin in food has worked satisfactorily and there is practically no evidence of cases of poisoning attributable to excessive tin content of canned foods. We think a limit should be maintained since a high tin content in food would be contrary to good commercial practice and possibly injurious. In view of improvements in the canning process introduced since 1908, when the informal limit was recommended, we should prefer a figure of 250 parts per million."

The Sub-Committee made no recommendations on foods and beverages which are not subjected to a canning process.