# FOOD PRESERVATION QUARTERLY

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DIVISION OF FOOD PRESERVATION,
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# Mould Wastage in the Storage and Transport of Fruit

By

S. M. SYKES.*

### Importance.

The loss of fruit by mould wastage is a major problem in storage and transport. The term "mould wastage" is here used in a popular sense and covers all wastage due to fungal rotting. There are many other functional or non-parasitic disorders which, in the past, have caused serious wastage in stored fruit, but, with the improvement of storage technique, these disorders are becoming less important. The result is that a greater proportion of the losses in storage is now due to mould. There is also some evidence of an actual increase in the amount of rotting in recent years, one possible cause being a change in the orchard spraying schedule resulting in reduced use of copper sprays. In fruit stored experimentally, rotting has often been responsible for more than 50% of the total wastage. Even though the number of rotted fruits per case may be small, the value of the fruit lost can be very high when expressed on the basis of the whole season's crop. Thus, the wastage for one season in shipments of Palestine oranges to Great Britain averaged 5%, but the financial loss was estimated at approximately £135,000. A few rotted fruits will reduce the market value of a case to a greater extent than the proportion of fruit lost.

### Factors Affecting Mould Development.

The factors determining the amount of mould decay can be divided into two groups: (1) pre-harvest factors, i.e. those concerned with the growing of the fruit, and (2) factors related to picking, handling, grading, packing and storage.

### Pre-harvest Factors.

In the first group would be included all of the many factors which (*a*) affect the fruit's resistance to fungal invasion before or after picking, and (*b*) determine the incidence of rot-producing spores in the orchard.

The variety and type of fruit affect the degree of wastage. Under normal conditions, Valencia oranges show less wastage than Washington Navels. Some varieties of apples are longer-keeping and less liable to mould than others. The locality, soil, rainfall and manurial treatment all appear to have an effect on subsequent rotting in storage. There is some evidence that nitrogen manuring increases susceptibility to mould attack. Other work indicates that the rainfall, both in amount and distribution, affects the degree of rotting. Heavy rain late in the growing season seems to render the fruit more liable to mould attack. The effect of the late rain may operate in several ways: (1) There may be a direct lowering of the mechanical or physiological resistance of the skin to fungal attack. (2) The skin may be more susceptible to mechanical injuries. (3) The spore load of the fruit may be increased. (4) The

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moist conditions may favour spore germination. The first two factors may be directly due to growth of the fruit as a result of the rain.

The influence of orchard factors on fruit resistance to mould decay is a complex subject about which information is still incomplete.

Orchard sanitation is important where fungal spores which later cause rotting are present in the orchard. Mould spores may be carried on the fruit for some time without any development of rotting. They may remain ungerminated on the skin or an incipient infection may occur through the lenticels. The bull's-eye rot of stored apples is thought to be due to such a "latent" infection and there is some evidence that it can be reduced by the application of a late Bordeaux spray. The destruction of windfalls, the removal of diseased and dead wood, a correct spraying schedule and the maintenance of a good standard of cultivation will help to reduce the chances of infection. These practices are particularly stressed in relation to control measures for brown rot of stone fruits and stem-end rots of citrus fruits.

### Picking and Post-harvest Factors.

Of the factors affecting mould decay, those of the second group, i.e. from the time of picking to the end of storage life, are most important in that they are, in general, more subject to control.

Since there are three prerequisites for satisfactory mould growth—(1) presence of the viable mould spore, (2) access of the mould to the fruit tissue (generally through breaks in the skin), and (3) favourable conditions of host, temperature and humidity for satisfactory growth—any particular control measure will operate through one or more of these factors.

### Maturity.

The maturity of the fruit at picking is related to wastage, the less mature fruit being usually more resistant to fungal attack. Rotting in Navel oranges generally increases with later picking, but in Valencias does not appear to be related to time of picking.[1] In storage experiments at Homebush in 1942, mould wastage in Granny Smith apples after 14 weeks at 48° F. was 10% for an early picking and 52% for a late picking. It must be remembered, however, that the susceptibility to some functional disorders, such as superficial scald in apples and storage spot in oranges, is greater in fruit picked early, and the flavour of such fruit may not be fully developed. Most trouble seems to arise from picking fruit when it is over-mature. Many pear growers use hormone sprays to prevent the dropping of fruit before harvest and, as a result, there is a tendency to leave fruit too long on the trees. Some of the recent losses in stored pears may have been due to the delay in picking following on the application of hormone sprays.

### Fruit Size.

The size of fruit is another factor which may influence rotting. There is some evidence that larger apples are more liable to mould attack than smaller ones. The size effect may be an indirect effect of maturity in that larger fruit is, in general, more mature physiologically than smaller fruit from the same picking, and fruit picked later will be larger than fruit picked earlier.

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[1] Huelin, F. E. (1942).—"The Handling and Storage of Australian Oranges, Mandarins, and Grapefruit." Coun. Sci. Ind. Res. (Aust.) Bull. 154, pp. 21-22.

## The Picking Box.

The picking box may be a dangerous source of infection. If old boxes are used it may be necessary to sterilize them to reduce the load of rot-producing spores. Steam treatment or the use of a suitable fungicide such as sodium hypochlorite have been effective in reducing mould infection from boxes. Mechanical injuries may be serious in rough or badly made boxes. The box should be strongly constructed, smooth inside, and should be lined on the bottom with wood wool or strawboard.

## Weather Conditions.

Fruit should not be picked wet or too soon after rain. As well as increasing the spread of spores and the chances of their germination wet weather renders the fruit more turgid and therefore more liable to mechanical injury.

## Mechanical Injury.

The importance of mechanical injuries as a cause of mould wastage cannot be over-emphasized. The skin of the fruit is a natural barrier to the entry of moulds and it has been found that most infections occur through mechanical breaks in this barrier. Skin punctures, stem-end injury, bruises, scratches, calyx and lenticel injury and insect punctures are all avenues for infection and should be avoided.

While a certain amount of injury in the normal handling of fruit is probably unavoidable, it is certain that, with a reasonable amount of care, much of the wastage from this source could be eliminated.

The use of poor equipment for picking, grading, packing and transport contributes to mechanical injury. In picking care should be taken to avoid punctures from finger-nails, injury from clippers with citrus fruits, overloading of picking bags and boxes and the rough transfer of fruit from bag to box. The grader and other fruit handling or processing equipment should be carefully checked for sources of mechanical injury. The bouncing or crushing of fruit, the overloading of bins and the accumulation of grit in graders should be avoided. The abrasive action of brushes in citrus processing machinery often results in scratches and punctures on the skin of the fruit. Correct packing is, of course, essential in the prevention of injury during transport or handling in storage.

## Plant and Shed Hygiene.

Apart from the danger of mechanical damage to the fruit the packing house can be a serious source of infection if steps are not taken to keep the incidence of rot-producing spores at a minimum. The frequent removal of accumulated rubbish, especially rotting fruit, is most important and the periodical spraying of the shed and plant with a suitable antiseptic solution is desirable.

## Fungicides After Picking.

Cleaning or fungicidal solutions are sometimes used on the fruit before packing. The dipping of citrus fruit in 5% borax at 90°–110° F. to control green mould or the dipping of packed bananas in "Shirlan" to control squirter disease are common commercial practices.

## Coatings and Wraps.

The use of waxes and other materials as skin coatings may be beneficial in reducing mould wastage as well as in retaining the condition and palatability of the fruit. Further work needs to be carried out on the possibility of incorporating fungicides in these coating preparations.

Much experimental work has been devoted to the control of decay, particularly of citrus fruit, by wraps treated with mould-inhibiting substances. Diphenyl wraps have given successful results with citrus and wraps impregnated with copper sulphate are recommended in America for the control of Botrytis rots in pears. Sodium metabisulphite in the form of dust or tablets is used commercially in the prevention of mould decay in packed grapes.

## Mould and the Cool Store Operator.

The following are most important aspects of mould control from the point of view of the cool store operator.

(i) *Prompt Storage.*

The time between picking and cool storage should be reduced to a minimum. If the fruit must be held for some time before packing it should be held in as cool a place as possible. (There are exceptions to this rule, e.g. citrus fruits are sometimes held for a few days at high temperatures to toughen the rind before placing them in store.)

(ii) *Rapid Cooling.*

The temperature of the fruit should be lowered as quickly as possible after placing the fruit in cool storage. However, it is not good practice to put warm fruit directly into the store with cold fruit, and the use of a pre-cooling system may sometimes be necessary.

(iii) *Temperature and Humidity.*

The temperature and humidity should be maintained at the correct levels for the particular fruit. The higher the temperature, the higher is the rate of development of mould ; too high a humidity will also favour mould growth. On the other hand, too low a temperature may induce non-parasitic disorders (e.g., low temperature breakdown of apples and storage spot of citrus).

The effect of temperature on the time of development of rots in oranges is shown in the following table.[2]

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 92° | 75° | 70° | 65° | 60° | 55° | 50° | 45° | 40° | Temperature F. |
| ∞ | 3 | 4 | 5 | 6 | 8 | 10 | 16 | 30 | Days for rot to develop |

(iv) *Cool Store Sanitation.*

The cool store should be thoroughly disinfected between seasons. The rooms should be first given a hot wash with a suitable detergent solution and then sprayed with a solution of chlorine or sodium hypochlorite. Finally the room should be fumigated with formaldehyde gas.

(v) *The Avoidance of Over-storage.*

Fruit should be removed from store and marketed before it deteriorates to an over-stored condition. The resistance of the fruit to the development of rots decreases as the storage period increases and the losses in over-stored fruit may be very high.

[2] Tomkins, R. G. (1936).—*J. Soc. Chem. Ind.* 55 : 68 T.

## Transport.

Careful and rapid transport to the market is most desirable. Because of the necessity for closer stacking in railway vans, special care must be taken to provide adequate ventilation to guard against sweating and heating which favour rapid rotting. Floor dunnage and correct stacking technique will ensure satisfactory air circulation and the prevention of mechanical damage to the packed fruit.

## Marketing.

Because of the greater susceptibility to mould after long storage, the object of the wholesale and retail agent should be to dispose of fruit as rapidly as possible. During the period from storage to consumer the fruit should be held in cool well-ventilated places whenever possible.

It will be obvious that mould wastage in stored fruit is a matter that concerns everyone from the grower to the seller. It is only by a co-ordinated effort in correct cultural, storage and handling methods that the serious losses from this source can be significantly reduced.

# Chemical Preservatives in Foodstuffs

PART 3.

By

M. R. J. SALTON AND D. F. OHYE.

## Miscellaneous.

1. *Curing Ingredients.*

Although the components of curing solutions are not included in the Food Act definition of a "preservative", it is felt that some mention of their rôle in the prevention of spoilage should be made.

Sodium chloride, sodium or potassium nitrates, sodium nitrite and sugar are the active ingredients of meat-curing solutions. The inhibitory effect of sodium chloride has been recognized since early times. However, the preservative rôles of sodium nitrate and sodium nitrite have been disputed for some time. Recent work seems to indicate that these compounds may possess value as bacteriostats.

## Sodium Nitrate.

Early students of meat curing generally attributed the value of nitrate to its effects on colour. However, as Jensen (1942) points out, the addition of nitrate to sausage meats or curing solutions does not "fix" colour until nitrate-reducing bacteria form nitrite. The nitrite in turn reacts with the muscle hæmoglobin to form the desirable pink pigment, nitrosohæmoglobin.

Jensen (1944) states that "in the field of the microbiology of meats, these are few subjects over which there has been more controversy than the effect of sodium nitrate on anaerobic bacteria in meats". Tanner (1944) refers to experiments carried out by Lewis and Moran, who found that 4·4% of sodium nitrate was completely effective in checking the proteolytic activity of *Clostridium putrefaciens* in pork-infusion medium. Pettersson (quoted by Tanner, 1944) reported that meat and fish with from 5% to 15% of saltpetre putrefied when kept at 77° F. However, this worker showed that mixtures of small amounts of saltpetre and salt were active antiseptics. Evans and Tanner (1934) observed that spoilage of cooked and uncooked meat was not prevented by adding 0·1%-2·0% sodium nitrate in combination with 3·5% sodium chloride. Large-scale tests carried out by the Swift and Company Research Laboratories (Jensen, 1944) showed that nitrate is of benefit in preventing growth of *Clostridium sporogenes*. In these tests, treated cans of spiced ham contained 0·125% sodium nitrate, 0·015% sodium nitrite, 3·5% sodium chloride, 2% sugar, together with some spices.

In summing up the preservative values of sodium nitrate, Jensen (1942) states "the literature on the effects of nitrate on bacteria in meat shows unmistakably that nitrate in the cure exerts a definite inhibitory effect on bacteria. Adequate plant tests indicate that nitrate in the cure is of benefit in preventing the putrefactive anaerobes from growing in canned comminuted ham and luncheon meats.

## Sodium Nitrite.

Tanner and Evans (1934) studied the inhibitory effect of sodium nitrite on putrefactive anaerobes (strains of *Clostridium botulinum*, *Clostridium putrificum* and *Clostridium sporogenes*). Results showed that concentrations of sodium nitrite from 0·1372% to 0·588% in plain broth cannot be relied upon in itself to prevent spoilage or toxin formation by these organisms. Stephenson (1939) and Landerkin (1940) have both observed that the growth of bacteria is inhibited by 0·4% of sodium nitrite. Bittenbender (1940) claims that a 38·8% solution of sodium nitrite at pH values between 3 and 8 exhibited no bactericidal properties.

Tarr (1941) has shown that under certain conditions nitrites may play an important part in retarding growth of many kinds of bacteria and thus delay the onset of spoilage. He found that inhibition of the growth of bacteria by sodium nitrite is largely dependent on the pH of the substrate, a factor which previous investigators had failed to take into account. At pH 6, 0·02% (the maximum concentration permitted by law), sodium nitrite may entirely inhibit growth, while at pH 7 little or no inhibition of growth is evidenced.

The effectiveness of ice containing sodium nitrite for fish preservation has been demonstrated by Tarr and Sunderland (1940). They state that bacterial spoilage of dressed halibut, pink salmon and black cod is markedly inhibited by icing with crushed ice containing small amounts (0·1%–0·5%) of sodium nitrite, instead of with ordinary ice. It is of interest to note that ice containing 0·1% of sodium nitrite is much more effective than is ice containing an identical proportion of benzoic acid.

In a report on further studies of the use of germicidal ices, Tarr (1946) had demonstrated that the pH of the fish flesh influences the efficacy of the ices. In ling cod, the flesh of which was only very faintly acid, sodium nitrite ice was ineffective in retarding bacterial spoilage. When treated with nitrite ice, bacterial spoilage of lemon sole and scaly-fin flounder (possessing flesh which is more acid than ling cod) was considerably retarded.

2. *Organic Acids.*

Unlike mineral acids, the inhibitory effects of organic acids are disproportionate to the degree of dissociation and are due mainly to the undissociated molecule, or the anion, or both. With mineral acids, on the other hand, inhibition of growth of microorganisms is related to the hydrogen ion concentration.

Acetic and lactic acids are those most commonly used in the preservation of foodstuffs. It has been found that acetic acid is a better preservative for pickles than lactic acid. Levine and Fellers (1940) also indicate that acetic acid is more toxic than lactic acid for bacteria, yeast and moulds. These workers, Levine and Fellers (1940) later reported that acetic acid concentrations of 0·17%, 0·27% and 4·73% inhibit the growth of bacteria, moulds and yeast respectively, in the presence of 5% brine and 20% syrup. Erickson and Fabian (1942), investigating the preservative action of organic acids in the presence of sugars, found that for bacteria the order of decreasing effectiveness was lactic, acetic, citric. In an article on the control of spoilage in bread, Glabe (1942) refers to the use of the peculiarly bound compound of sodium acetate and acetic acid, known as sodium diacetate, as a strong inhibitor of mould and "rope". The normal sodium salt of acetic acid, he states, has practically no inhibitory effect.

The discovery of the preservative action of propionic acid was the result of systematic study of the flavouring principles present in dairy products, cheese in particular, and the study of the fungistatic properties of the fatty acids. It was noted that the American Swiss cheese was more susceptible to mould attack than the imported cheese. The finding that the latter cheese had a considerably higher content of propionic acid, contributed to its use as a mould inhibitor in packet cheese, cottage cheese and cream cheese. The relatively high volatility, together with its solubility and flavour characteristics limit its use as a general preservative. However, loss by volatilization may be reduced by the use of calcium or sodium salts. Whilst the flavour of propionic acid is objectionable in many products, it does improve others. Propionic acid is essentially an inhibitor of respiration, although the mechanism of its action is still unknown.

Propionic acid and its salts have been widely recommended for the prevention of spoilage in foods. To prevent the growth of mould on soft cheese, about 0·15% calcium or sodium propionate is sometimes used. The calcium and sodium salts are effective inhibitors of mould and "ropiness" in bread, being used for this purpose in the United States. Calcium propionate in 0·1%–0·5% concentration is effective in preventing mould growth on fruit jellies, glaze jelly and similar products. Dipping containers or wrapping materials in dilutions of 8%–10% propionate is also effective against mould attack. The use of propionic acid or propionates as preservatives in foodstuffs is not permitted in Australia.

3. *Monochloracetic Acid.*

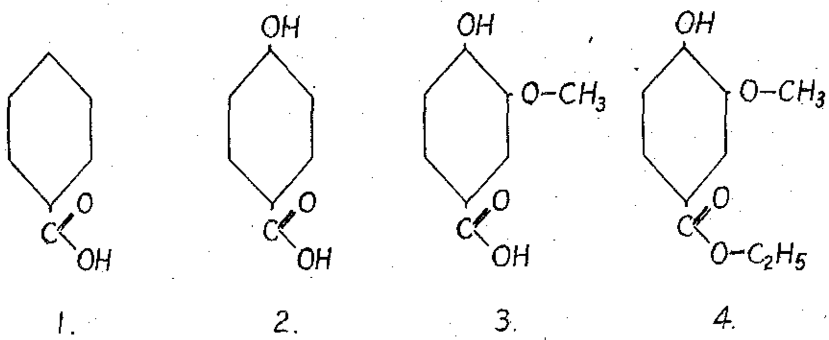
The Food and Drug Administration of the United States has banned the use of monochloracetic acid as a preservative, although there are strong advocates for its use. Leake (1942) maintains that monochloracetic acid is rapidly destroyed in the body and is well suited to the rôle of a preservative since it slowly decomposes to form sodium acetate and sodium chloride, and within a period of several weeks disappears from the food entirely. Joslyn and Cruess (1942), however, support the ban by the Food and Drug Administration on the use of monochloracetic and claim that benzoic acid is preferable as a preservative. The work of Fabian and Bloom (1942) showed that in fruit juice benzoic acid inhibited the growth of microorganisms to a greater extent than did monochloracetic acid. Both chemicals were more effective against yeasts than acid-producing bacteria. Morrison and Leake (1941) concluded that there was no significant public health hazard involved in the use of monochloracetic as a food and beverage stabilizer in concentrations of 0·05%. They found that there was no irritation to human mucous membrane or skin with concentrations below 5%.

No reliable data on its toxicity have yet been published. If proven to be non-toxic, monochloracetic acid has certain advantages, as it blends well with most fruit products, particularly fermented fruits and vegetable products. The other advantage is that it has only a temporary preservative effect, being transformed into non-toxic compounds on storage. However, benzoic acid or sulphurous acid will control the growth of microorganisms equally as well as monochloracetic acid and are preferable until more light is thrown on its toxicity.

4. *Vanillic Acid Esters.*

The search for new perservative agents has, in recent years, led to the investigation of the esters of vanillic acid. Pearl (1945) and Pearl and McCoy (1945) have pointed out the need for non-toxic preservatives to be used in perishable foodstuffs shipped or stored without the benefit of refrigeration.

Vanillic acid is a derivative of para-hydroxybenzoic acid. The esters of para-hydroxybenzoic acid have received much attention as preservatives in general, in addition to which they have been used to a considerable extent in goods in Europe. The structural diagrams below show the relationships between benzoic acid (1), para-hydroxybenzoic acid (2), vanillic acid (3) and the ester ethyl vanillate (4).




In general, the antimicrobial efficiency of the vanillic acid esters increases with increasing molecular weight up to the butyl ester, and then decreases. Toxicity studies so far indicate that when administered in olive oil to rabbits or rats, ethyl vanillate and sodium benzoate have approximately the same lethal dose. On administration in aqueous suspension, the vanillate is much less toxic than the benzoate.

According to Pearl (1945), food preservation studies demonstrate the efficiency of vanillic acid esters in preserving such foods as salt fish, fresh fruit juices, vegetable juices, cheese spreads and bread. In addition to the inhibition of yeast fermentation of glucose noted by Sabalitschka and Tietz (quoted by Pearl), investigations have indicated that these compounds are especially effective against heat-resistant spore-forming bacteria and moulds.

Pearl and McCoy (1945) state that the United States Federal Food and Drug Administration will accept the use of ethyl vanillate in amounts up to 0·1%, where it can be demonstrated that it will make possible the delivery of acceptable food products to the armed forces.

### 5. Antibiotic Substances.

Antibiotic substances have come to the fore in recent years with the use of penicillin in medicine. In addition to penicillin such substances as gramicidin, pyocyanine and tyrocidin are distributed widely in nature, and, in small concentrations possess the ability to inhibit the growth of microorganisms. It is conceivable that these substances may be incorporated in foodstuffs to act as preservatives. Curran and Evans (1946) investigated the inhibitory effects of penicillin on bacterial spores in milk which had been heated so as to destroy the vegetative forms and non-sporing organisms. Their results showed that penicillin could not be used effectively as a preservative in milk, because some of the organisms present were extremely resistant to its action. Other tests in milk showed streptomycin to have only limited preservative properties.

In view of the present findings it seems unlikely that these compounds will find widespread use as preservatives. Firstly, to be successful they would have to be inhibitors of the wide variety of microorganisms encountered in food spoilage. Secondly, it is unlikely that the cost would ever be sufficiently low to permit their use as general preservatives.

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# The Corrosion of Tinplate Food Containers

By
HUGH A. McKENZIE.

The tinplate industry consumes nearly four million tons of steel and about sixty thousand tons of tin every year. More than half the total production is used as a packaging material for foods of all kinds. Australia alone in 1938–39 imported 70,000 tons of tinplate worth £1,800,000 and in 1943–44, 120,000 tons worth £3,700,000. In the first year she produced from these imports food cans to the value of £3,200,000 and the second year cans worth £9,500,000. It is not surprising, therefore, that much research, both pure and applied, has been carried out on the corrosion of tinplate food containers.

The mechanism of the corrosion of tinplate (the tin-iron couple) is quite complex. It suffices here to give a short summary of the work of Morris and Bryan. The corrosion of iron is considerably decreased by contact with tin, but that of tin is increased. However, the total corrosion of the couple is much less than for a similar area of iron alone. In general, the corrosion of the tin member of the couple increases with increasing pH. Hydrogen gas can only be liberated from the iron. There are, however, other factors involved, some of which have been revealed by Hoare.

The internal corrosion of the tinplate container will be considered first. Hydrogen gas is produced in reactions between the product and the tinplate. Hydrogen evolution is extremely slow in most products, but in some fruit packs it is sufficiently rapid to produce a positive pressure and to swell the can within a fairly short storage period at moderate temperatures. The headspace gases of cans at this stage usually contain over 90% hydrogen, and the cans are known as " hydrogen swells ".

In Australian canned fruits, such as peaches, pears and apricots, the incidence of hydrogen swells under normal marketing conditions is very low; but serious outbreaks occur from time to time in Great Britain in such packs as cherries and plums. Hydrogen swells are rejected since it is not possible, without analysis of the contents, to determine if the spoilage is microbial in origin. Hydrogen swells in canned fruit have been adequately discussed by Hirst and Adam. During the course of examination of army foodstuffs, during the war years at the Homebush laboratory, hydrogen swells were encountered in a number of packs not usually regarded as being prone to this type of spoilage; for example, tomatoes, beetroot, parsnips and meat pastes. Factors probably contributing to these outbreaks were lightly coated tinplates, long storage life in army dumps in warm areas and low initial vacuum.

There are three possible modes of attack to reduce the incidence of hydrogen swells:

(1) Addition of corrosion inhibitors to the pack.
(2) Coating of the tinplate with a protective layer.
(3) Adjustment of the chemical composition of (*a*) steel baseplate or (*b*) the tin coating.

It is doubtful if much success will be achieved by attack along the lines indicated by (1) and (3) (*b*).

Considerable success in the reduction of hydrogen swells has followed the application of lacquers to the can (method (2)). However, the need for taking precautions to ensure an unbroken lacquer film cannot be too strongly emphasized. If the lacquers are imperfectly applied severe localized attack may occur at discontinuities in the lacquer film and lead to rapid hydrogen swelling. In fact, the majority of hydrogen swells examined at Homebush have been berry jams packed in badly lacquered cans.

Perhaps the most promising line of approach is adjustment of the steel baseplate composition. It is well known that the corrosion of steel is markedly dependent on its composition. An extensive study of the influence of baseplate composition has been made by Hoare, Morris and Adam.

The influence on hydrogen swells of sulphur, phosphorus and copper was statistically examined. It appeared that a high copper content (about 0·2%), with a phosphorus content as low as possible, was important. However, subsequent work, particularly by Hartwell, has shown that the optimum composition of the steel is dependent on the food being packed. Although the problem is an exceedingly complex one, it is possible to specify steel compositions suitable for various packs.

The information given in Tables 1 and 2 on typical steel baseplates used in the U.S.A. has been kindly supplied by the Carnegie-Illinois Steel Co.

TABLE 1.

| Type. | Use. |
|---|---|
| L. | Corrosive fruit products. |
| MR. | Less corrosive fruit products, peaches, pears and apricots. |
| MC. | Vegetable, meat and fish cans. |

TABLE 2.
*Chemical Composition (Per Cent.).*

| Type. | Carbon. | Manganese. | Phosphorus. | Sulphur. | Silicon. | Copper. |
|---|---|---|---|---|---|---|
| L. .. | 0·05–0·12 | 0·25–0·60 | 0·015 max. | 0·05 max. | 0·01 max. | 0·06 max. |
| MR. .. | ,, | ,, | ,, | ,, | ,, | 0·20 ,, |
| MCT4 | ,, | ,, | 0·03–0·05 | ,, | ,, | ,, |
| MCT5 | ,, | ,, | 0·05–0·11 | ,, | ,, | ,, |

When foods rich in proteins, such as meat, fish and certain vegetables, are packed in unlacquered cans, staining of the can frequently results. This purple, brownish or black discolouration is usually caused by a film of tin sulphide, but in severe cases may be due to iron sulphide.* These conditions are usually associated with a general etching of the tin surface known as "feathering". Sometimes the iron sulphide is formed as a loose deposit and this may appear in the food product on its removal from the can. From the consumer's point of view the latter is the more

* Discoloration of fruits and vegetables can also be due to the effect of tin on anthocyanins.

objectionable form of staining; but even when, as in most cases, the contents are not stained, the blackened interior of the can detracts from the appeal of the product.

The prevention of staining by the use of lacquers and protective films has been investigated by Sumner, by Kerr and by Kefford and Lynch. The latter authors, working at Homebush, have examined the following preventive treatments:

(1) Internal lacquering with commercial "sulphur-resisting" lacquers.
(2) Deposition of anodic oxide films within the can by electrolysis in alkaline media.
(3) Simultaneous deposition of a lacquer film and an oxide film by electrolysis of a lacquer emulsified in sodium aluminate solution.
(4) Chemical formation of a protective film by immersion in hot, alkaline oxidizing phosphate medium.
(5) Chemical formation of a protective film, followed by one sprayed coat of gold stoving lacquer.

With sausages, peas, corned beef, asparagus, sweet corn, cream, french beans, cabbage, celery, pumpkins, carrots, parsnip and cauliflower, blackening was completely inhibited in filmed cans. With tuna, onions, spinach and boiled mutton and lamb there was slight staining. With beetroot there was no can staining, but there was some loss in colour.

In addition to internal corrosion of the can, external corrosion may occur. Various factors responsible for external corrosion are spilling of syrups or brines during filling, improper retort operation, and cooling in contaminated waters. In addition to these types external atmospheric corrosion may also occur. This usually takes place during storage for long periods in moist air. Two external treatments to prevent atmospheric corrosion are lacquering and production of protective films by treatment of the cans after heat-processing and cooling.

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# Selecting Flooring Materials for Food Factories

By

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In choosing suitable flooring materials for the food factory, it is desirable that the materials should be (1) capable of being formed into a continuous smooth surface, (2) resistant to wear, (3) resistant to chemical attack by materials likely to come in contact with them, (4) non-slippery, (5) poor conductors of heat, so that they are warm to stand on, (6) productive of only a low level of noise during movement over them, (7) of low cost.

Without the continuous smooth surface it is not possible to maintain the cleanliness essential in a food plant, as material lodges in the cracks and becomes a breeding ground for spoilage organisms. A contribution to factory hygiene is the development, at the Mellon Institute of Industrial Research, of " Hubbellite ", a magnesium oxychloride cement containing finely divided copper salts. It can be applied as a thin surface layer on any floor and is claimed to act as a cockroach repellant and to be lethal to microorganisms.

A serious cause of abrasion and cracking in factory floors is the use of heavy trucks with steel-tyred wheels and no steering devices. The greater outlay on rubber-tyred wheels with ball bearings would result in economy of time, effort and floor maintenance, and reduce noise considerably.

In the food plant, wooden floors do not stand up to continuous wetting, and concrete floors are attacked chemically by oils and fats, by lactic acid from milk, acetic acid in vinegar and pickled foods, the acids of fruit juices, sugar solutions, all sulphate salts, also thiosulphates and sulphites. Aluminous cement is more resistant to these substances than Portland cement. Solutions of common salt, unless very strong, do not attack cement, but can cause very serious corrosion of the reinforcement if they penetrate to it.

Fitzmaurice and Lea (1939) state: " The resistance of flooring materials to chemical attack is interlinked with the effect of abrasion. Thus, in the case of the commonest flooring material, concrete, there are many substances giving rise to troubles with floors which attack concrete so slowly that they have been successfully stored in concrete tanks. When abrasion is absent the attack may be limited to the surface and, though this causes softening, the continuation of the reaction is greatly retarded by the surface products. In the case of floors, however, any such softened surface layer may be removed by abrasion, and the action proceeds more deeply into the concrete. It is indeed the combination of very heavy wear with chemical attack in such cases that often makes the provision of durable floors difficult unless recourse is had to the expensive specialist materials."

A non-skid surface not only contributes to the comfort of the workers, but is essential for safety. Many materials, such as wooden planks, concrete and ceramic tiles, which are safe when dry, may become very slippery when wet or greasy. Abrasive-ingrained vitreous tiles or brick containing iron ore which is fused during the baking to provide iron particles throughout the brick are probably the most successful materials developed to prevent slipping. They may be used in aisles where the traffic is heavy. Metal plates with a raised pattern may also be used, but they are noisy, hard on the feet, conduct electricity, and make trucking difficult. Abrasive floor paints are being investigated and may in future solve this problem.

Some research on the effect of flooring on the productivity of workers has shown that a resilient, quiet flooring increases their output. In one factory it was found that men standing on a concrete floor did, in the same time, the equivalent of only six and a half hours' work compared with eight hours from men working on a wooden floor.

Some characteristics of different flooring materials are set out below.

*Wooden planks* stand up poorly under moist conditions and heavy wear. *Creosoted wooden blocks* are more resistant to liquids and wear and are easier to repair than planks. It is difficult to fasten machinery to them, however. Expansion joints are necessary along walls and around columns, as the blocks may expand 5% of their volume when wet. A bituminous or asphalt material between the blocks also allows for expansion. The blocks are usually laid on a concrete base.

*Composition floors* include cement and cement concrete, asphalt mastic, asphalt blocks, magnesite and various patented compositions. A *cement concrete floor* is comparatively cheap, easily cleaned and non-slippery but its advantages end there, and as a rule it should be regarded as a foundation for a surface material specially suited to the type of factory. A coat of paint may overcome " dusting ", and solutions of sodium silicate, aluminium sulphate, zinc sulphate, magnesium and zinc silico-fluorides also drying oils are used for hardening the surface. The drying oils are most efficient in reducing dust. All these hardening agents make the floor more slippery and do not afford much increase in its resistance to chemicals.

*The asphalt compositions* most commonly used are asphalt mastic and asphalt emulsion. They are useful for patching broken concrete and damaged floors of other types, and are a useful covering for wooden floors. The asphalt emulsion has the advantage that it contains water as a solvent where the asphalt mastic contains an organic solvent which is more expensive and constitutes a serious fire hazard while being laid. These floors are resilient, warm, quiet, non-slippery, hard-wearing and waterproof, and can be made practically acid- and alkali-proof. Some of the older types of asphalt floors softened in hot weather, but this difficulty is now said to have been overcome. However, these floors are not very suitable for contact with oils and fats, syrups or solvents, nor for cold rooms, so their use in food factories is limited.

" Magnesite " (magnesium oxychloride) is much more resistant to abrasion than other flooring materials, and is slightly better than Portland cement in resistance to food materials. It corrodes some metals and therefore should not be allowed to come in contact with pipes, etc. The metal may be protected from contact by bituminous paint.

*Bricks* are acid- and oil-resistant and can easily be replaced, but their porous nature makes them likely to absorb liquids, and the joints between them constitute a weakness. Blue bricks set in aluminous cement mortar make a good floor.

It is apparent that no one flooring material can be described as the best. Different departments of the same plant may have different requirements, and the conditions in each should be considered separately, and the material which is likely to give the best performance under these conditions should be selected.

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# Information Available on Food Storage

A bibliography and information summary on Preservation and Storage of Bacon available on application to

C.S.I.R. Information Service,
425 St. Kilda Road,
Melbourne, S.C.2.

Applicants are asked to state clearly why they require the bibliography, as in some cases only limited numbers are available.

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# Staling of Bread

" A Review of Progress in Research on Bread Staling ", by William H. Cathcart, appeared in *Cereal Chemistry*, v. 17, pp. 100–21 (1940). The following summary of this paper, which appears to be of particular interest at present, is taken from *Chemical Abstracts*, 1940.

This review attempts to explain what happens when bread stales; it discusses methods of measuring staleness and summarizes methods of preventing staleness. The inadequacy of our present knowledge of what happens when bread stales, the disagreement between physical or mechanical methods and the results of personal judgment as to the rate of bread staling, the lack of scientific research on the effect of certain processes, ingredients, etc., in preventing bread staling, and discrepancies in existing data make definite conclusions difficult, and point to the need for further scientific research. Some processes and ingredients delay staleness, while others have little effect, if any, and in some cases even decrease bread quality. Many methods recommended for delaying crust staling increase crumb staling, and *vice versa*. The two most effective methods for delaying crumb staling are heat and cold, yet these are not entirely practicable at the present time.

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# Curing and Smoking of Fish

Two articles on the curing and smoking of fish were prepared last year by W. A. Empey and R. Allan, of the Division of Food Preservation.

The first article dealt with species of fish suitable for curing and smoking, apparatus needed, the methods for bringing and smoking the fish and its subsequent storage. The second article gave details of the construction of a kiln. These articles were published in the " Fisheries Newsletter " of the Ministry of Post-War Reconstruction (Vol. 5, Nos. 1 and 2, 1946), as it was thought that such a journal would reach most of the people interested in the treatment of fish. Copies are available from the Division of Food Preservation, Council for Scientific and Industrial Research, Private Mail Bag, Homebush, N.S.W.

# Transport of Peas to the Cannery

*In Australia, where many of the canneries are situated in towns* some distance from where the crops are grown, the loss of vitamin *C* and general deterioration of vegetables before reaching the cannery may be serious. It is reported in the "Food Packer", October, 1945, that the Hanover Canning Company in U.S.A., who had to bring their peas a ten-hour journey to the factory, experimented with several methods of holding them. They found that the best results were obtained by equipping trucks with large watertight tanks with baffles and covers to prevent shifting and splashing of the load. The tanks were filled with peas which had been shelled and washed and were just covered with cold water to which was added enough chipped ice in half-pound pieces to keep the temperature at 45° F. until the cannery was reached. It was found that peas carried in this way could be held for as long as twelve hours and still produce a canned product whose colour, texture and flavour were indistinguishable from one canned on the spot. Analyses showed that only 10% of vitamin *C* was lost from peas after soaking for six hours in the iced water.

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