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AND INDUSTRIAL RESEARCH

Hawkesbury Agricultural College as a Training Ground for Food Technologists

By

By E. A. SOUTHEE, O.B.E.*
and C. J. HORTH, H.D.A.†

Almost since its foundation in 1891, Hawkesbury Agricultural College has been intimately connected with the canning industry. For the most part this association has been related to the production side and to the home canning of fruit and vegetables, but in more recent years the College has been of assistance to the canning industry in the production of new varieties, field trials of imported varieties and in a minor way in testing their suitability for canning.

In addition, canning firms have appointed to their staffs a considerable number of ex-students holding the Diploma in Agriculture (H.D.A.) of the College and possessing the agricultural (field) background to the industry's requirements.

From our contacts with representatives of all sections of the industry, it has been evident for some years that there was a pressing need for trained operatives and processors in the canning factories.

In view of the outstanding success of the College in providing a course of training suitable for dairy produce factory operatives, it was considered that a course on generally similar lines would be of particular benefit to the fruit and vegetable canning industry.

Prior to World War II, the Australian canning industry, though well established in certain areas, had, none the less, a limited variety of production. Other than meats and meat by-products, the only food available in any quantity for general consumption was fruit. Other foods, e.g. fish, vegetables, received but little attention, public preference being biassed in favour of the imported article.

The export pack received well merited attention, high standards in quality (soundness, colour, uniformity) were defined, and a well trained export inspection staff kept a watchful eye to prevent any deterioration in the Australian product. At times some concern was exhibited by processors in regard to the amount of blemish showing in some deliveries, while growers became periodically agitated about low yields.

World War II imposed a hitherto undreamt task on the industry; "Defence" demanded an almost immediate increase in production, and in very short time.

New crops were needed—hundreds of acres—and new establishments to process the vast increase in production. Quantity was the prime need and soundness and palatability the yardstick of quality.

The maintenance of today's post-war demand at a high level involves the provision of canned goods of

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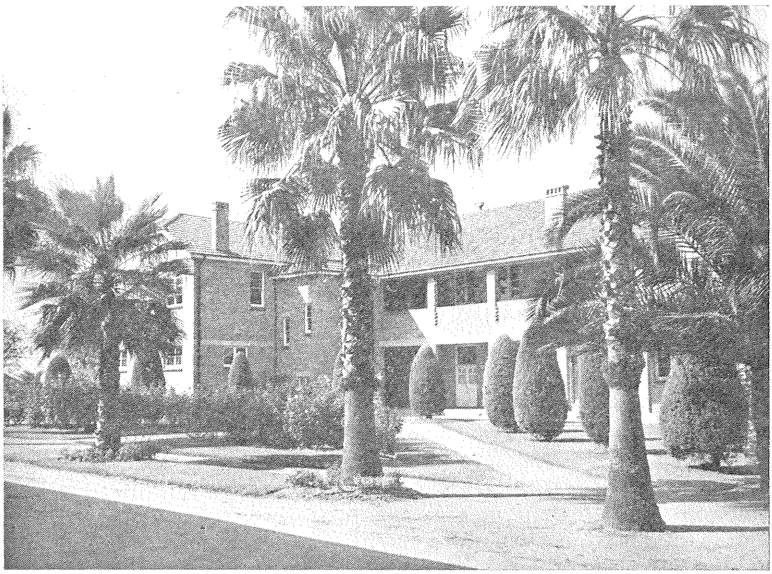
(1) high nutritional value,
(2) excellent eating quality,
(3) non-luxury cost.

It would be wrong to assume that processing technique and research had accomplished little over the period of rapid expansion. It would also be just as wrong to assume that production and processing problems had all been solved.

Today's problems then become:

(1) A need for high quality production in the field;
(2) further technological research;
(3) training of field officers with a knowledge of both processing procedure and agricultural production to (*a*) organize and direct quality production in the field and (*b*) carry out research on production problems.



Laboratory, Hawkesbury Agricultural College.

High quality production in the field involves consideration of a wide range of factors, e.g. soundness, freedom from blemish, low content of indigestible fibre, characteristic and pleasing flavour, high energy values, high nutritional and protective food values. Quality in the processed article must be as good as the best on the raw product market, not in order to sell at the expense of the fresh food market, but to at least stand on an equal footing.

Attaining this standard in the field means careful attention to such details as selection of suitable soils, sites and locations; selection of suitable varieties and correct planting; fertilizing; cultivation; determination of the correct stage of maturity for harvest; methods of picking and methods of packing for transportation to the factories.

Controls of growth and other field problems have to be investigated and the correlation between these and the canned product must be understood.

Not only is the extension field inadequately served, but there will always be research problems ahead of the trained investigator.

Consideration of a few of the problems confronting the producer will serve to show the extent of the field awaiting exploration, and the highly specialized nature of canning crop production.

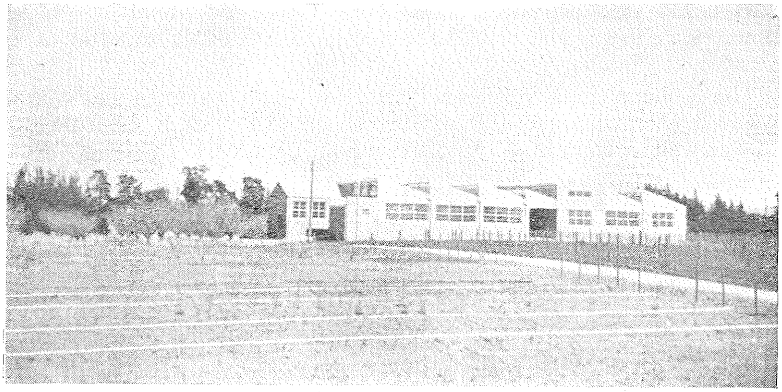
Some of the matters on which more information is required are :

What factors control tenderness in root crops—is it soil, seed, location, rate of growth, variety ?

What is the influence of fertilizer treatments and soil management practices ?

What is the influence of varying soil moisture relations on the growth rate and on maturity of root crops, of green crops, of pome, stone, citrus fruits and berry fruits ?

Has soil management any influence on tomato juice quality, on the ascorbic value of citrus juice or on the solids-acid ratio in oranges or in grapefruit ?



New Cannery, Hawkesbury Agricultural College.

Are pectin quantity and quality functions of the variety of fruit or of growth conditions, location ?

To what extent do orchard practices, e.g. irrigation, thinning of the fruit, influence fruit size and quality ?

Do weedicides and arsenicals affect citrus acidity, and would this effect have any real significance on ultimate quality ?

What is the relation between plant varieties and districts ?

It is obvious, then, that a knowledge of canning procedure—treatment, processing, biochemical control—would, when coupled with special crop and soil studies from the field to the factory, form an excellent foundation for either farm production, field supervision or further training in the higher industrial field.

In the light of knowledge of the requirements of the industry from all points of view—production, processing, research and personnel—the Minister for Agriculture approved of the institution of a special course of instruction at Hawkesbury Agricultural College and funds were made available for the erection and equipping of a small modern cannery. The building has been completed and the plant and equipment are in process of installation. The canning and dehydration plant is designed to handle both root and green vegetables, tomatoes, pears, peaches and apricots for canning, jam, and citrus fruits for juice.

It is considered that the College is an ideal place for the training of operatives for the canning industry and for investigation into problems connected with the field production and processing of food products, particularly fruit and vegetables. Already considerable success has been achieved by the College plant-breeding staff in the development of new varieties and strains of fruits and vegetables (e.g. bean, cucumber, melons) by hybridization and selection. Twelve acres of river alluvial soil—typical of vegetable areas in the Hawkesbury district—have been set aside for vegetable investigational and experimental work. The College cannery is situated in the centre of the College orchard of some forty acres, thus providing an ideal situation for the training of operatives, giving, as it does, complete observation and specialist crop supervision from field to can. In addition, as the College is situated in the centre of a large producing area, students would have the advantage of gaining contact with commercial growers and their problems. Laboratory facilities and staff are already available for instructional and investigational work in the chemical, bacteriological and other scientific aspects of canning technology.

The College as a resident institution—and with the advantages associated therewith—would be able to cater for students from other States as well as from all parts of New South Wales.

NEW JOURNAL.

In July the Australian Institute of Refrigeration (Inc.) began to issue its monthly " Refrigeration Journal ". This periodical will contain original and reprinted articles as well as the reports of the Institute's activities. Its format is attractive and it should prove a valuable source of information for the Australian food industry. The publisher's address is 26 Blackwood Street, North Melbourne, N.1, and the subscription for non-members in British countries is 31s. 6d. per year or 3s. 6d. per issue.

RODENT INFESTATION.

A number of pamphlets on the above subject are obtainable, free of cost, from the New South Wales Department of Public Health, and no doubt from other Health Departments. The N.S.W. pamphlets give advice on trapping and poisoning, and on means of denying rats access to buildings and foodstuffs. They should prove most helpful to managers of food factories and to others concerned with the storage of food.

The Handling of Fresh Citrus Fruits

By
E. G. HALL.

These notes are concerned only with operations up to the stage of packing fruit in the case and do not deal with storage, "curing" or transport. However, the nature of the handling operations will be influenced by the use to which the fruit is subsequently put. If it is for immediate factory use relatively little care is necessary, whereas if it is intended for storage, export, or marketing in a distant mainland centre, special care should be taken.

The following considerations are involved in handling:

(1) Picking methods.
(2) Transport to packing shed.
(3) Grading to remove diseased, injured or sub-standard fruit.
(4) Cleaning to remove surface dirt and surface mould blemishes such as sooty mould and sooty blotch.
(5) Practices or treatments to retard or prevent, loss by rotting, shrivelling of the fruit and loss of palatability.
(6) Attractive presentation involving size grading as well as quality grading, packing, wrapping and type and appearance of container.
(7) Careful handling at all stages to minimize mechanical injuries.

(a) Types of Wastage in Citrus Fruit.

(i) *Fungal Wastage*—rots and spots of various types. In Australia, as in most other citrus producing countries, the common green mould (*Penicillium digitatum*) is the most important cause of wastage. Blue mould (*Penicillium italicum*) is also important on fruit from inland areas. Normally these cannot infect uninjured fruit. They cause soft rots which develop rapidly at temperatures between 60° and 80° F. Control is secured by careful handling to reduce wounding, by sanitation to reduce contamination of the fruit by spores of the fungus and by chemical antiseptic treatment of the fruit with such materials as borax or salicyl-anilide (Shirlan) to prevent growth of the mould on the fruit. Rotting is also considerably retarded by holding the fruit at low temperatures, for instance, green mould will appear on inoculated oranges after only three days at 75° F. but will take 30 days to develop at 40° F.

Stem end rots are next in importance. These are firmer, somewhat pliable rots beginning as a gradual brown or drab discoloration advancing from the stem end. They develop much more slowly than green or blue mould. They are not usually important in inland fruit but may cause serious wastage in coastal fruit which is held at temperatures above 40° F.; at higher temperatures stem-end rots may appear after one or two weeks.

Rots or rind spots can be caused by other fungi, but they are not usually of any importance in ordinary marketing.

(ii) *Physiological Rind Blemishes*. These are non-parasitic in origin and are generally only of significance in refrigerated storage, being mainly forms of cold injury. Storage spot, pox or pitting is the most important and takes the form of discoloured, more or less sunken areas on the skin. It occurs almost invariably when fruit is stored for several weeks at temperatures below 45° F. Below 37° F. cold injury takes the form of a superficial scald.

Oleocellosis or oil burn is frequently observed on fruit picked early in the season. It is a slightly sunken, often greenish, discoloration of the skin initially showing between the oil glands and is due to rupture of oil glands and release of oil which, in fruit not fully mature, is toxic to the skin tissue. Oleocellosis develops more rapidly at high temperatures and is usually brought about by rough handling; or the oil glands may be ruptured by heat, as when fruit is held at higher temperatures for colouring or when fruit is passed through heated solutions for cleaning or fungicidal treatment.

(iii) *Shrivelling*. After picking, moisture lost from the fruit as a result of its normal life processes is not replaced and this loss soon results in the development of a wilted, unattractive appearance. Shrivelling is not apparent until the fruit has lost approximately 5 per cent. of its original weight. Under certain conditions citrus fruits may also develop discoloured desiccation blemishes on the skin.

(iv) *Loss of Palatability*. Palatability is a combination of taste, flavour, juiciness and texture. Juiciness and pulp texture may improve after picking, but taste, which is a balance of acid and sugar content, and flavour (due to the presence of certain volatile compounds) usually declines slowly. In addition, stale or foreign flavours may develop, especially in fully mature fruit, if it is held for relatively long periods, particularly at high temperatures.

(b) Handling Practices.

The way in which the fruit is handled from picking onwards, particularly in regard to wounding and sanitation, has an important bearing on wastage. The following is a summary of the more successful of the methods available for improving the storage life of the fruit. These methods have not yet been fully adopted by Australian citrus packing houses.

Prior to harvesting and during the several processes between picking and marketing, the fruits are liable to mechanical and physiological injury and to fungal invasion. The importance of careful handling cannot be over-emphasized. The ubiquitous green mould is a wound parasite and any mechanical injury to the fruit will serve as an avenue for infection.

Orchard sanitation is important in relation to wastage. Pruning out dead wood, spraying, and the maintenance of a good standard of orchard cultivation have been shown to be important in the control of certain forms of wastage, particularly stem-end rot.

(1) *Picking*.

In order to avoid injury, oranges and lemons should be clipped from the trees with special clippers, while mandarins may be pulled and grapefruit either pulled or clipped. If oranges are to be marketed and consumed within a week, pulling is satisfactory, otherwise mould wastage is likely to be increased and the practice then becomes uneconomic. It is required that all oranges and lemons for export should be clipped. Under the best conditions of handling, the fruit is also picked into special bags, filled into field boxes and transported to the packing shed for treatment and packing. In picking, gloves should be worn to minimize injury to the fruit, stems should be clipped close, making two cuts if necessary, and a layer of wood wool should be placed in the bottom of the field box to reduce injury. Under conditions where stem-end rot is likely to be important, as indicated by the presence of melanose infection, pulling the fruit is more satisfactory than clipping. The removal of the button removes infections harboured in and about the stem at its point of attachment to the fruit, and this reduces the incidence of stem-end rot. Picking should not be carried out while the trees are wet with dew or immediately after rain, as the then turgid fruits are easily injured and the oil liberated from the rind, particularly early in the season, may cause oleocellosis. These blemishes and injuries predispose the fruit to subsequent rotting.

Most of the New South Wales coastal fruit, however, is sold locally on the Sydney market and much of this is pulled and packed on the orchard, without being processed in an equipped packing shed. Often, processing would improve the appearance, and therefore the sales value of the fruit, and at times could reduce wastage.

(2) *Transport to the Packing Shed.*

Investigations into the sources of wounding have shown that considerable damage can be done during transport to the packing shed. To reduce injury, picking or "field" boxes should be well constructed, free from rough edges or surfaces, splinters, or protruding nails. During the picking operation the boxes should be laid out on grassy spots or raised off the ground to prevent the entry of soil particles which will injure the bottom fruit in the box. A common source of injury, especially during transport, is over-filling of the field cases; they should be filled only to within half an inch of the top. Every care should be taken to avoid movement of the fruit in the boxes during transport, rapid travel over rough roads being especially bad.

(3) *Handling in the Packing Shed.*

(*a*) *Sweating and Colouring.* After picking, fruit, if it is intended for export or storage, is commonly sweated or wilted for a few days before being packed. Sweating is of value in reducing shrinkage after packing and thus maintaining a firmer pack. The effect on subsequent wastage of sweating Australian fruit has been variable. In regard to mould control, any value lies in toughening the rind and in drying out small wounds and in allowing already infected fruit to be detected and removed. Sweating for ten days at 70° F. has been shown to reduce considerably the pitting of the grapefruit, during subsequent storage at susceptible temperatures. Sweating may also be effective in reducing storage spot of oranges.

Early Navels and late picked Valencias are often somewhat green in colour, the former on account of immaturity and the latter because of regreening as a result of renewed vegetative activity. This fruit can be coloured by the use of ethylene or acetylene gas under appropriate conditions. For satisfactory colouring, oranges are treated for two to three days with ethylene at a concentration of 1 : 5000 at a temperature of 75° F. and a humidity of 85-90 per cent. These conditions are ideal for the growth of fungi so that the colouring process often increases subsequent wastage; it is generally considered to weaken the fruit.

To minimize this effect it is recommended that fruit be treated with borax or Shirlan as soon as possible after picking and before going into the colouring room.

(*b*) *Prevention of Wounding.* Careful handling is very necessary in the packing shed as, unless specifically guarded against, considerable wounding can take place during passage of the fruit through the plant with resultant danger of increased wastage by mould.

All equipment should be kept in good mechanical condition and should be carefully inspected at least twice a week to ensure that at no point is fruit being unnecessarily injured.

The most important cause of injury to the fruit is usually the hopper into which it is tipped from the field cases. The fruit should be very carefully transferred from the field cases to avoid damage and the hopper should have no rough edges or projecting nails which would injure the fruit and should have a slatted floor to allow débris to fall through. A very satisfactory type is one with a floor of parallel steel bars covered with soft rubber tubing. The sides should be covered with sponge rubber sheeting, cemented on and not nailed, as in time the nail-heads become exposed.

Other sections of the processing and packing plants may cause wounding of the fruit. For example " dirt knobs " often develop and injure the fruit ; they should be scraped off as soon as observed. These sharp excrescences are built up when oranges are wounded at any point ; a small amount of oily exudate is deposited and accumulates dust, and by repetition of this " dirt knobs " are formed. Some types of size graders have an excessive drop into the bins. Careless lidding, and packing with an excessive bulge, may also cause considerable injury to the fruit.

(*c*) *Prevention of Contamination.* The first condition for the development of mould wastage is the presence of wounds in the fruit, the second is the presence of spores of the mould. The presence in the shed for any length of time of only one or two mouldy fruits, each of which produces millions of spores, will heavily contaminate the atmosphere of the shed. The aim of good shed management should be to keep mould contamination at as low a level as possible ; this involves the control of both air-borne and equipment-borne contamination. Field cases are frequently a serious source of contamination. They should be kept clean. Cleaning and sterilizing can be done very satisfactorily with live steam.

The shed and all equipment should be kept clean by frequent washing down and all waste fruit should be placed in covered bins and removed daily.

To reduce equipment contamination, thorough old-fashioned soap and warm water cleaning to remove all dirt is much more important than the use of " high-power " fungicides. Air-borne contamination can be reduced by sprays of suitable fungicides ; 0·5% formalin is effective but is too irritant for general use. The use of other materials is being investigated. However, elimination of mouldy fruit from the shed and thorough cleaning of equipment will steadily reduce the extent of air-borne contamination.

It cannot be emphasized too strongly that heavily contaminated (mouldy) fruit must be kept off the clean fruit line if contamination of the fruit is to be effectively reduced. This is best done by passing the fruit, before it passes through the processing equipment, over an inspection belt where mouldy fruit can be seen and removed.

(4) *Processing.*

In a fully equipped citrus packing shed facilities are available for cleaning the fruit, treating with fungicides and finally waxing before grading and packing. These operations are standard practice in most American citrus packing sheds but few sheds in Australia are equipped for complete processing.

(*a*) *Washing.* This is necessary to remove superficial dirt and certain superficial pathogens of the rind (notably sooty mould and sooty blotch), which are common on coastal fruit. In washing, various alkaline cleaning compounds are used. The fruit is first passed through a warm (100-110° F.) cleaning solution in a soaking tank and is then brushed under sprays where removal of dirt is completed. Soda ash and sodium silicate (sold as " M1 " and " Metsil "), and the less alkaline and therefore more satisfactory sodium cetylsulphonate (" Lissapol ") have been found to be effective cleaning compounds.

(*b*) *Fungicidal Treatments.* After passing from the cleaning brushes the fruit should be put through a bath of fungicidal solution also maintained at a temperature of 100-110° F. Both the cleaning and fungicidal efficiency of appropriate solutions increases with increasing temperature, but above 110° F. fruit is likely to be damaged. A solution of borax in 5-8 per cent. concentration has been found to be a most effective solution for control of green mould. Salicylanilide or its sodium salt (" Shirlan ") in concentrations as low as 0·25 per cent., has also been found to be an effective fungicidal dip and is more effective than borax against stem-end rots. Unless the solution is heated a concentration of borax greater than 4 per cent. cannot be maintained. If heating over night is impracticable, a solution of 2 per cent. borax and 1 per cent. caustic soda could be used. This is equally effective as a fungicide but will increase wilting a little more than borax alone. Many American sheds use a 7 per cent. solution of two parts of borax to one part of boric acid. For greatest efficiency the fungicides should be left on the fruit and not rinsed off, as is sometimes done.

(*c*) *Waxing.* The next treatment in the full processing schedule is waxing with the object of coating the fruit with a very thin film of wax to reduce wilting and improve appearance. Treatment with alkaline materials such as borax, unless they are washed off, considerably increases the rate of wilting of the fruit and therefore waxing to counteract this is particularly desirable.

There are four methods of waxing:

(i) *Cold Slab.* Paraffin wax is transferred from a block to the fruit by means of revolving brushes. This is the cheapest method and can be quite satisfactory. It is widely used in America.

(ii) *Hot Fog.* The fruit is sprayed with atomized molten wax in a waxing chamber maintained at about 160° F.

(iii) *Solvent Process.* The fruit is sprayed with an atomized solution of wax or mixture of waxes dissolved in special volatile solvents.

(iv) *Emulsion Dip.* The fruit is passed through a bath of a dilute (2-4 per cent. solids) water-base emulsion of wax or wax mixtures; other materials such as oil or shellac are often incorporated in the various commercial formulæ.

The inclusion of high melting point vegetable waxes such as carnauba, candellila, lac, etc., in the mixture considerably increases final lustre, but these waxes are not quite as effective as paraffin wax in reducing wilting. Good commercial waxing should reduce weight loss (wilting) by 30-35 per cent., although many American sheds are satisfied with a reduction of 20-25 per cent.

Citrus fruits become noticeably wilted when they have lost 5 per cent. of their weight; waxing will postpone the development of noticeable wilt for several days, which is a considerable advantage in the interstate or country order trade. Emulsion waxing is rather expensive but requires no special equipment and has the advantage that fungicides can be incorporated in the emulsion; a disadvantage is that emulsions break rather easily when diluted with hard water. Waxing has no definite effect on wastage (either rotting or the development of skin spotting) in cool storage.

(*d*) *Wrapping*. For local marketing citrus fruits are not usually wrapped; for distant marketing wrapping is very desirable, and for export it is compulsory. Ordinary sulphite tissue wraps are usually used but these do little more than give some mechanical protection and to some extent reduce shrinkage due to restriction of air movement over the fruit.

Oiled wraps, waxed wraps, and wraps of semi-greaseproof paper give greater control of wilting and also reduce contact spread of rots. Present information from America indicates that, in California, wrapping in special wraps of paper impregnated with oil and a small amount of wax is considered more satisfactory than waxing, better control of wilting being obtained. Also, mouldy fruits are more or less isolated in the wrap. Wraps of such materials as cellophane and pliofilm have been tried experimentally in this country but, besides being rather expensive, have been shown to be not yet suitable for general commercial use.

Chemically treated wraps of various types have been proposed at various times for control of mould wastage and several have been tried out experimentally. The most successful has been a wrap impregnated with a small quantity of diphenyl (about 0·02 gramme per 10×10 ins. wrap), which has given good control of both green and blue moulds and stem-end rots. Diphenyl slowly volatilizes and has a definite odour, hence there is a tainting problem associated with its use. Such wraps are being used to some extent in America but they are not generally favoured because of slight tainting of the skin.

Enzymes in Food Preservation

By
F. E. Huelin.

Enzymes are colloidal protein catalysts produced by living organisms. They occur in all living cells, in body fluids, and in secretions such as digestive juices and milk. Some microorganisms liberate enzymes into the surrounding medium. Living tissues contain a large number of enzymes, each promoting a different chemical reaction. Most enzymes are readily destroyed by heat. As all foods are derived from living organisms, the influence of enzymes in their deterioration is of considerable importance.

In considering the influence of enzymes in foods, a distinction must be made between those foods which are still composed of intact living cells and other foods composed of dead and injured tissues. In the intact cells, the enzymes are distributed spatially within the complex living structure, which serves to coordinate the various enzyme reactions. Death and injury destroy this coordination, with the result that some enzymes are destroyed while others may function with much greater activity. The resulting uncoordinated enzyme reactions may cause rapid deterioration in some products.

Enzymes in Intact Living Tissues (Fresh Fruit and Vegetables).

Fresh fruit and vegetables remain living plant tissues after harvesting, and their preservation in a sound condition is dependent on the maintenance of healthy living cells. Various chemical reactions, such as are associated with respiration and ripening, take place in the normal tissue. These reactions involve the presence of a series of enzymes whose action is coordinated within the living tissue. Disorders which occur in stored fruit and vegetables are probably the result of uncoordinated enzyme reactions associated with the death or injury of cells.

It is expected that studies of the enzymes involved in the respiration and ripening of fresh fruits and vegetables would give considerable help in problems of deterioration. However, very little work has been carried out in this field, and no relation between enzyme action and any storage disorder has yet been established.

Enzymes in Dead and Injured Tissues.

Non-living tissues include most flesh foods and frozen, dried, or canned fruits and vegetables. Unless inactivated by heat, many of the enzymes are still active and can bring about undesirable changes. Slicing or other disintegration of the tissue in preparation for processing destroys the organization of the living cells and enables uncoordinated enzyme action to take place in the damaged tissue. Freezing also largely destroys the cell organization. It retards the enzyme reactions but does not destroy the enzymes. Canning procedures are usually sufficient to destroy all enzyme activity in the final product, but drying alone (i.e. without a preliminary heat treatment) is not usually sufficient.

Following are some of the enzymes which can cause deterioration in fruit and vegetable products :

(*a*) Polyphenol oxidase (apple, potato), which promotes the oxidation of phenolic substances in the tissues to give brown and black discolorations. This enzyme can promote indirectly the oxidation of ascorbic acid (vitamin C).

(*b*) Ascorbic acid oxidase (cabbage, cauliflower), which promotes directly the oxidation of ascorbic acid (vitamin C).

(*c*) Lipoxidase (legumes), which oxidizes unsaturated fats and indirectly carotene (provitamin A).

(*d*) Pectase (citrus juice, tomato), which destroys the natural pectin. The pectin stabilizes the suspended material of the juice, and its destruction causes flocculation.

An enzyme which destroys thiamin (vitamin B_1) has been found in carp tissue.

Enzyme action may sometimes improve the product, e.g. in the "ripening" of beef. In this case the enzymes of the meat play a part in the breakdown of the connective tissues which results in increased tenderness.

Heat Inactivation of Enzymes.

In order to avoid deterioration in colour and flavour it has been found necessary to "blanch" many varieties of fruits and vegetables prior to freezing or drying. "Blanching" is a short exposure to boiling water or steam to inactivate the enzymes responsible for deterioration.

A simple enzyme test is desirable to determine whether blanching is adequate, i.e. whether the enzymes have been completely inactivated. Little is known of the probably large number of enzymes responsible for deterioration in quality, but it is possible to use a single enzyme test, if the heat treatment required to inactivate this enzyme is approximately the same as the heat treatment required to inactivate the enzymes responsible for deterioration.

The catalase test was first suggested by Diehl, Dingle and Berry (1933) to test adequacy of blanching for frozen storage. Catalase is the enzyme which splits hydrogen peroxide to oxygen and water. More recently Joslyn and others have found that the point of inactivation of peroxidase corresponds more closely with adequate blanching. Peroxidase promotes the oxidation of phenols and other aromatic substances to coloured products by hydrogen peroxide, and the development of a colour indicates a positive peroxidase test. "Peroxidase", as usually found in fruit and vegetable tissues, is probably a complex of enzymes, as the time of inactivation depends on the substrate, i.e. the oxidizable substance used for testing. The best correlation with adequate blanching, as indicated by subsequent examination of frozen or dried foods, has been obtained by using guaiacol as the substrate.

The peroxidase test, as recommended by Joslyn (1946), is as follows : Place 5 g. of small pieces of cut tissue in a test tube and add 5 ml. of water, 1 ml. of 1% guaiacol in alcohol, and 1 ml. of 0·5% hydrogen peroxide. (The hydrogen peroxide should be free from acetanilide.) Note the colour after two to five minutes. Any appreciable browning indicates a positive peroxidase test and inadequate blanching. Adequately blanched material should be practically unchanged.

The heat inactivation of pectase is of considerable importance in stabilizing the suspended material in tomato and citrus juices. The pectase activity of tomato flesh is extremely high, and Wildman (1930) found that, if unheated tomatoes are crushed, about 70 per cent. of the natural pectin is destroyed in ten minutes. In view of this, a preliminary heating before extraction of juice, known as the "hot break" process, was introduced. In studies of heat inactivation, Kertesz (1939) found that 45 seconds at 80° C., 37 seconds at 85° C., and 32 seconds at 90° C. was sufficient to inactivate the tomato pectase. It would, of course, be necessary for every part of the tissue to experience these conditions.

Joslyn and Sedky (1940) investigated the heat inactivation of enzymes responsible for the clearing of citrus juices. They found that the time (one minute) required to bring the juice to a bath temperature of 90° C. or 100° C. was sufficient to inactivate the enzyme. The usual pasteurization processes should be sufficient for inactivation.

Use of Enzymes.

In this section the use of added enzymes, i.e. those introduced into foods from other sources, will be considered. The use of rennin, a proteolytic enzyme obtained from the calf's stomach, in the manufacture of cheese is well known. The proteolytic enzyme papain (obtained from the papaw) is used for tenderizing meat.

The inactivation of pectase in tomato and citrus juices in order to stabilize the suspended material has already been mentioned. Where a clear juice is required, it is necessary to flocculate the suspended material. This can be done by adding a pectolytic enzyme. Commercial preparations from moulds are available for the clarification of apple and grape juice. Willaman and Kertesz (1931) give a method for preparing a pectolytic enzyme from *Penicillium glaucum*.

In the manufacture of pectin from apple residues (particularly from immature apples) it is often necessary to remove starch from the extract, as this would cause cloudiness in jellies made from the pectin. This can be done by adding a starch hydrolysing enzyme. Commercial preparations, such as taka diastase from the fungus *Aspergillus oryzae*, are available for this purpose. Such preparations usually have some pectolytic activity, hence the enzyme treatment must not be too prolonged. Baker (1936) has shown that the treatment is best carried out at 30° C. and pH 3·2-3·6 to avoid destruction of pectin, which may occur at higher temperatures and pH. After treatment, the extract is heated rapidly to 80° C. to inactivate the enzyme.

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Use of Aluminium for Food Cans

By
P. THOMPSON.

The recurring restrictions on the use of tinplate for many different products, including certain food packs, turns attention to the possibilities of using other materials. While cardboard, fibre and combination metal-and-paperboard cans may be used to a certain extent for non-processed food products, a definite need exists for a material possessing all, or a great percentage of, the characteristics that have made tinplate preeminent in the field of food canning.

Particular characteristics essential for food containers are ease of fabrication, resistance to corrosion, structural strength and freedom from toxicity. Considering all these essentials the material that receives first consideration must be aluminium.

The aluminium industry is highly developed technologically, and no difficulties exist in producing metal of high purity to close dimensional tolerances in sheets, strips, coil, etc. No difficulties exist regarding availability of supplies, particularly since the cessation of hostilities, and the falling off of requirements for the aircraft industry has resulted in the aluminium industry seeking outlets for their greatly augmented production.

Fabrication.

Fabrication of aluminium into food containers must necessarily be done at high speed to compete with standard tinplate lines. The formation of containers according to conventional methods is not at present feasible due to the difficulty of soldering aluminium at high speed. However, during the war developments in the field of synthetic adhesives produced several formulations giving excellent metal-to-metal joints. In some instances the strength of the joints is claimed to be superior to spot-welded or rivetted joints and in addition the bonding temperature is considerably lower than that of spot-welding. Further work in this field may ultimately permit the fabrication of aluminium cans from the sheet metal witout the necessity of after-treatment to remove corrosive flux, etc.

The ductility of aluminium renders it readily adaptable to deep drawing and extrusion. A limited number of aluminium containers have been made by these methods. In Norway, for example, a large proportion of canned sardines is packed in shallow-drawn, aluminium cans, while collapsible aluminium tubes are not uncommon, particularly in the cosmetic industry.

Drawing of metals has been practised over a long period and application of the process to aluminium differs little from other metals except in operational details regarding radii of the tools, amount of reduction per draw, etc. During the drawing operation a distinct increase in temper results, so that the second and third draws must be considerably less than the first. However, with intermediate annealing, it is considered that there is virtually no limit to the ultimate size of the container, apart from economic factors.

It is generally considered that cans of the conventional tall type can be satisfactorily made in three draws without intermediate annealing, although latest information suggests the possibility of producing a No. $2\frac{1}{2}$ can by a single draw.

Impact extrusion, in which a carefully calculated volume of metal is expanded to give an aluminium tube (closed at one end) when struck by a hammer, is probably the most spectacular and promising method for producing aluminium containers. For this purpose metal of very high purity is needed since impurities greatly increase the wear on the tools. Recent information reveals that during the early part of the second world war the German can-making industry investigated extruded cans. One firm produced 1-kilogram cans with presses having a rated capacity of 500 tons, while a second company used a modified process permitting the production of " cans " several times the length required which were subsequently parted off to give two, three or four cans, depending on the size required. This development greatly speeded the rate of production.

Thus it may be seen that no great difficulties lie in the way of mass production of aluminium cans, and, with the accumulation of experience and operative data, the best of the three methods of fabrication, outlined above, will be proved on a basis of costs.

Resistance to Corrosion.

Chemically, aluminium is a most reactive element, and yet with food products a remarkable corrosion resistance is exhibited, due to the presence on the surface of the metal of the relatively inert oxide layer.

Generally, corrosion of food containers is limited to the effect of hydroxy organic acids (citric, tartaric), water, brine, sulphites and hydrogen sulphide. With aluminium, water and hydrogen sulphide are entirely without effect, although the other agents do have a corrosive action.

Normal salt brine, a constituent of many packs, has a definite pitting action on aluminium, especially in dilute solutions, but such attack can be inhibited by small additions of sodium silicate.

The hydroxy organic acids and their sodium salts are fairly active corrosive agents. Other organic acids vary in their reactivity with aluminium. Fatty acids (such as oleic, palmitic and stearic) react vigorously with the metal when dry, but in the presence of water no reaction occurs. Acetic acid reacts mildly in dilute solution, though the presence of salt increases the rate of corrosion.

Sulphites and sulphurous acid cause pitting, the rate of corrosion increasing with concentration.

Aluminium differs from tin in that it is more reactive with alkalis generally, although sodium silicate is the notable exception, since it acts as an inhibitor.

With all of these agents corrosion resistance varies with the purity of the metal, the higher the purity, the greater the resistance to corrosion.

As with tinplate, processes have been developed to improve the corrosion resistance of aluminium. Chemical and electrolytic methods of depositing resistant films on the metal surface as well as conventional lacquer treatment have all proved advantageous for certain products.

Most of the exploratory work in using aluminium has occurred in Europe, notably Norway, Italy and Germany, and it is generally agreed that plain cans may be successfully used for fish, meat and milk packs, as well as other non-acid products above the critical pH value of 5·8. Reports from Germany indicate that asparagus, peas, green beans, carrots, cabbage and spinach were all satisfactorily canned and were generally considered superior in flavour to products packed in tinplate due to the elimination of the objectionable metallic taint.

Fruits and other acid products reacted with plain aluminium, rapidly producing hydrogen swells. However, carefully applied lacquer coatings successfully withstood such action. Electrolytically treated cans were found necessary for processed cheese due to discoloration caused by the peculiar oxide formation.

Freedom from Toxicity.

Much research work has been done on the alleged toxicity of aluminium, and the position is still not clear. Doubt exists regarding the assimilation of the metal by man, but it is definite that the amount of aluminium taken up during cooking in aluminium utensils does not exceed that occurring naturally in certain foods and is not harmful in such concentrations.

Special Precautions.

Early experiments with aluminium containers were carried out with sheet substantially thicker than tinplate in order to counteract the relative fragility of the metal. This naturally increased the difference in cost between the two containers. However, by using aluminium of the same gauge as tinplate and taking into account lower freight costs and higher scrap value of the can, the cost differential can be reduced to about 20 per cent.

In using aluminium of the same gauge as tinplate, special precautions are necessary. All handling must necessarily be supervised to ensure that cans do not receive the rough treatment normally given to the more robust tinplate cans. Double seaming differs slightly in that the setting of the baseplate and rollers is appreciably looser for the same reason. Aluminium cans lack the ability to resume their original shape upon cooling and thermal processes must take place in high pressure autoclaves to balance the pressure developed internally and prevent deformation. Application of pressure must also continue during the cooling phase of the process.

Precautions must be taken to prevent external discoloration of the cans in the retort due to electrochemical interaction between the aluminium and iron of the retort or retort cradle. Addition of sodium silicate (waterglass) to the water in the retort and lining the retort and cradle with aluminium are both effective inhibitors of this discoloration.

Final packing must be carefully handled and cases (or cartons) incorporating cardboard liners are necessary safeguards against mechanical damage.

Conclusion.

This brief survey indicates that, given a source of cheap aluminium, no serious difficulties, technical or economic, exist in the adoption of aluminium cans in the food industry. The slight extra cost per can might limit its utilization to packs commanding a premium on the commercial market, but with all products exhaustive tests should first be carried out before adopting the new type containers.

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Notes on The Mixed Storage of Foodstuffs

By
E. G. Hall.

Introduction.

In practice mixed storage of foodstuffs is often unavoidable and it is felt that a short discussion of what is generally recognized to be a risky undertaking would be of value to those who may be faced with it. It should clearly be realized that it is not good practice, and indeed, usually not possible, to store all types of foodstuffs in one room at one temperature, even for short periods. The main problem is tainting of one foodstuff by odours given off from another. A second important problem is that the optimum storage temperatures for different commodities vary widely, from below 0° F. to as high as 55° F. The purpose of these notes is to discuss briefly these two problems and to indicate to what extent mixed storage is practicable.

The Problem of Tainting.

All materials containing fat—meat, dairy produce and fish—absorb odours. Butter absorbs odours very rapidly and thus is very subject to tainting. Cream, whole milk and eggs are also more troublesome in this respect than meats. Therefore, these foodstuffs should not be stored with products which give off noticeable odours, such as fish, cheese and fruits, especially citrus fruits. It is possible to protect these taint-liable products to a considerable extent by careful wrapping in a suitable material such as heavy waxed paper, certain cellophanes (M.S.T. is satisfactory), saran, and pliofilm. If so wrapped they could be stored for short periods with odour-producing commodities without serious tainting occurring, but such wrapping would be expensive and usually uneconomic.

Most fruits and vegetables (with the exception of citrus fruits) can be stored together without tainting being a problem. If no other space is available oranges could be stored with other fruits and vegetables for periods up to three weeks.

The Problem of Storage Temperatures.

In addition to the main problem of tainting, the varying temperature requirements of different commodities must be considered. To allow of as much mixing of foodstuffs in one room as possible, a compromise in regard to storage temperature must be sought. This is an easier problem than tainting because the majority of foodstuffs can be stored at temperatures of the order of 32° F., although in many cases only for short periods. Certain fruits and vegetables, because of injury by low temperatures, must be stored at higher temperatures if required to be held for any length of time.

Fruits and Vegetables.

The different fruits and vegetables which can safely be stored at 32° F., and also those which require higher temperatures, are listed below.

(*a*) *Suitable for Storage at* 32° *F.*

Apples, pears, peaches, plums, nectarines, grapes, berry fruits, oranges (up to three weeks only), carrots, parsnips, beetroot, swedes, peas, beans, lettuce, silver beet, cabbage and cauliflower.

(*b*) *Require a Temperature of* 45° *F.* (*approx.*).

Oranges, ripe pineapples, coloured tomatoes, passionfruit, potatoes, cucumbers.

(*c*) *Require a Temperature of* 55° *F.* (*approx.*).

Lemons, grapefruit, green bananas, green pineapples, green tomatoes, sweet potatoes, pumpkins.

Animal Products.

The various animal products can be held at a temperature of 30-32° F. for short periods, and this temperature is suitable for a certain degree of mixed storage. The life of each product at 30-32° F. is approximately as follows:

Butter	Several weeks, but will be out of grade after two weeks.
Cream or whole milk	One week if pasteurised.
Eggs	Several months.
Cheese	Several months.
Meat	Up to 17 days.
Fish	6-7 days.
Green bacon	Up to 21 days.
Cured bacon	2-3 months.
Smallgoods—	
Sausages	Up to 14 days.
Spiced meats ..	Several weeks.
Dried egg and dried milk	Over one year.

It should be remembered that frozen storage at less than 15° F. is necessary for long storage of butter, meats, fish and bacon.

Practical Application.

Where storage of a range of types of perishable foodstuffs is required it is almost essential that animal products should be kept separate from fruits and vegetables. Only when storage for merely a few days is required would it be safe to have them in the same room, and even then, because of their greater liability to tainting, butter, cream and milk should be kept separately. Also, because of risk of tainting, these dairy products and also eggs, which can all be stored together, should be stored apart from meats and fish, both of which can be stored together for short periods without serious tainting. Obviously cheese, because of its strong odour, is a special case and must under all circumstances be stored by itself. There is a further practical point in regard to dairy products: they are specially liable to tainting by emanations from citrus fruits, and should be kept well away from them and also not stored in a room which previously held citrus fruits unless it has been thoroughly deodorized.

From the above considerations, neglecting cheese, and combining the two high temperature groups of fruits and vegetables, four rooms would be the very least number which would enable storage of all types of perishable foodstuffs :

One at 30-32° F. for butter, cream, milk and eggs.

One at 30-32° F. or a frozen store at 10-15° F. for various meats and fish.

One at 32° F. for fruits and vegetables listed under (*a*) (p. 53).

One at 50° F. for fruits and vegetables listed under (*b*) and (*c*) (p. 53).

If only one room would be available for all fruits and vegetables it could be held at a temperature of 38-40° F., which would allow for the inclusion of oranges and, for short periods of less than three weeks, coloured tomatoes, ripe pineapples, other citrus fruits and potatoes.

If only short storage of the order of a week is required, it would be better to run the room at a temperature of about 45° F. All types of fruits and vegetables could be mixed in this one room and, because of the higher temperature, condensation of moisture on the produce, or "sweating", after removal from store would be reduced.

Odour Control.

It is possible to deodorize a mixed storage room to a considerable extent and thus reduce tainting by the use of either ozone or activated charcoal.

Ozone.

This gas is a powerful oxidizing agent and if used in concentrations of 2-3 parts per million in the storage atmosphere will oxidize odorous volatiles and thus render them innocuous. Ozone is produced in low concentration from atmospheric oxygen by an electrical discharge and several types of ozone generators are available on the market. When used as directed these generators will maintain a sufficiently high concentration of ozone to neutralize odours.

Ozone is not suitable for use when the produce being stored contains appreciable quantities of fat, as it accelerates fat oxidation, with consequent rapid development of rancidity.

Activated Charcoal.

Charcoals and carbons specially prepared so as to have a very large surface in relation to mass are known as "activated" charcoals or carbons. These materials have a very great capacity for absorbing volatile substances and thus are very useful deodorizers. The storage atmosphere is caused to circulate through canisters or beds of activated charcoal at the rate of about 25-35 linear feet per minute. Approximately three pounds of activated charcoal is required for each 1,000 cubic feet of storage space. Activated charcoals can be rejuvenated by heat and used over again several times. When used at the above rate one charge should be adequate for a few months' storage. A commercial preparation has been used with considerable success in America for the storage of apples. It is believed that the use of activated charcoal in the mixed storage of foodstuffs would considerably reduce tainting and that it would be much more satisfactory than the use of ozone.

Conclusion.

From these considerations it can be appreciated that the mixed storage of a range of foodstuffs is a problem to which there is no easy solution. Except under conditions of extreme necessity, and then only for short periods, animal products must not be stored in the same room as fruits and vegetables. It is obvious that each case requiring mixed storage must be considered separately. The range of products for which storage is required must be taken into account. One must also consider whether storage is for short periods only or whether each commodity is to be stored as long as possible.

BIBLIOGRAPHIES AND SUMMARIES OF INFORMATION.

The following bibliographies, summaries of information and special reports have been prepared by the C.S.I.R. Information Service. Copies may be obtained on application to

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No.	Date Prepared.	Title.	No. of References.
B.243	May, 1947	References on the Inhibition of Potato Sprouting.	11
B.245	—	Summary of Information on Dugong Oil ..	—
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B.249	June, 1947	Bibliography of Rodents in Australia ..	72
B.270	July, 1947	Rat Poison 109 (Antu)—Summary of Information.	—
B.272	July, 1947	Instructions for Using Compound 1080 (Sodium Fluoroacetate) as a Rodent Poison.	—

RECENT PUBLICATIONS.

1. The Ascorbic Acid and Carotene Content of some Australian Fruits and Vegetables.

From 1942 to 1945 a considerable number of ascorbic acid determinations were carried out in the laboratories of Commonwealth Food Control and the Council for Scientific and Industrial Research on canned fruits and fruit juices, also fresh, canned and dried vegetables. These determinations were made in connexion with the supply of food to the services, and were directed primarily to ensuring maximum retention during processing. Some determinations of carotene were made during the same period. These data, which may be of general interest in the field of nutrition, were published in the *Journal of the Council for Scientific and Industrial Research*, vol. 20, p. 1, February, 1947.

2. The Influence of Ferrous Iron in the Determination of Ascorbic Acid.
By F. E. Huelin and I. M. Stephens. *Australian Journal of Experimental Biology and Medical Science*, vol. 25, p. 17, 1947.

Ferrous iron may occur in canned foods in concentrations up to 50 parts per million, and may cause positive errors in the determination of ascorbic acid. In 3 per cent. metaphosphoric acid, which is commonly used for extraction, ferrous iron reacts quantitatively with the dye 2 : 6 dichlorophenolindophenol, which is used for titration. The addition of 0·3 per cent. of hydrogen peroxide to the extract oxidizes the ferrous iron but may also oxidize some of the ascorbic acid. The positive error due to ferrous iron is converted into a negative error of less magnitude.

Ferrous iron interference and the stability of ascorbic acid were also studied in acetic and sulphuric acid extracts of canned foods. In these extracts the results are influenced considerably by pH and by low concentrations of oxalate, which may be derived from the products. Both iron interference and the stability of ascorbic acid are less at pH 0·4 than at pH 2-3. The oxidation of ascorbic acid in these extracts is due both to copper catalysis and iron catalysis. Copper catalysis is negligible at pH 0·4 but considerable at pH 2-3, while iron catalysis is considerable at pH 0·4 and only slight at pH 2-3.

Oxalate (0·01 M) strongly inhibits the copper-catalysed oxidation and partially inhibits the iron-catalysed oxidation. Chloride (0·1 M) increases copper catalysis and reduces iron catalysis.

A suggested procedure for eliminating ferrous iron interference involves extraction with 10 per cent. acetic acid containing 0·1 per cent. of oxalic acid. The pH is reduced to 0·4 by adding sulphuric acid just before titration.

Copies of these two papers may be obtained from The Librarian, C.S.I.R. Division of Food Preservation, Private Mail Bag, Homebush, N.S.W. Telephone UM 8431.

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