# FOOD PRESERVATION QUARTERLY

Volume 9, No. 3

September, 1949

43

46

5 I

456

Editor : W. A. EMPEY

# CONTENTS

Berry Fruit Juices-J. F. Kefford

The Production of Tomato Pulp-G. Greethead

The Pickling and Canning of Olives—P. Thompson ...

Answers to Inquiries

# Published by

THE DIVISION OF FOOD PRESERVATION AND TRANSPORT COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION: HOMEBUSH: NEW SOUTH WALLES, AUSTRALIA

# Plant Growth Substances Related to Problems of Fruit and Vegetable Storage

By

# D. MARTIN\* and R. N. ROBERTSON

Few fundamental discoveries in biology have led to such rapid and widespread applications as the discovery of the hormones, or growth substances, in plants. Following the early work, which appeared at the time to be rather academic, synthetic growth substances have been used successfully in many varied commercial practices. In addition, many effects have been observed which may be the forerunners of important applications in the future. In horticulture alone, growth substances have found many uses. Examples are in selective weed killing, plant propagation, fruit setting without pollination, bud inhibition and prevention of fruit drop. These applications have been summarised in two recent publications : "Growth Substances and their Practical Importance in Horticulture ", by H. L. Pearse (Commonwealth Bureau of Horticulture and Plantation Crops, Technical Communication No. 20, 1948) and "Hormones and Horticulture", by G. S. Avery, E. B. Johnson, R. M. Addoms and B. F. Thomson (McGraw, Hill, 1947). In storage of fruits and vegetables, growth substances have been shown to have both direct effects, in which the growth substance is applied to the stored product, and indirect effects, in which the storage life of the fruit or vegetable may be affected by the use of a growth substance prior to harvest. The purpose of this article is to review some of these effects.

## Sprout Inhibition in Potatoes

Probably the most important application in which the hormone has a direct effect upon the stored product is in the inhibition of sprout development in stored potato tubers. Sprouting has always been the principal factor limiting the useful storage life of most varieties of potatoes. Within the last ten years it has been shown that very good control of sprouting can be obtained with the methyl ester of  $\alpha$ -naphthalene acetic acid and this has become standard commercial practice in a number of potato stores overseas. The technique is already in use in Australia and its usefulness for Australian varieties under local conditions has been investigated by State Departments of Agriculture. One important recent development is the use of penta- or tetra-chloronitrobenzene which seems to be even more effective than methyl  $\alpha$ -naphthalene acetic (Brown, 1947); some work with a compound of this type has been done by the Victorian Department of Agriculture (Downie, 1949).

# **Ripening of Fruit**

The direct application of growth substances to some harvested fruits has been shown to accelerate ripening; the substance can be supplied in solution, either as a spray or as a dip for the fruit or vegetable. Mitchell and Marth (1944) reported that 2,4-dichlorophenoxyacetic acid hastened

<sup>\*</sup> An officer of the Division of Plant Industry, C.S.I.R.O.

the ripening of bananas, apples and pears but appeared to have little effect on ripening fruits such as tomato, persimmon and pepper which are low in starch reserves. With bananas, the hormone treatment gives some promise as an alternative to the usual acetylene or ethylene treatments. One advantage of this accelerating method is that the ripening of a batch of fruit was very even; this adds greatly to the appearance and attractiveness of a box of fruit.

# Scald in Apples

Schomer and Marth (1945) found a reduction in the amount of scald appearing in the apple varieties Arkansas, Stayman Winesap, Grime's Golden and York Imperial, after treatment with certain growth substances. The technique has not yet been used on any appreciable commercial scale and further investigations are necessary before its value as a scald control method could be assessed. Our knowledge of the cause of scald is limited to observation that it appears to be connected with volatile production. Whether the effect of growth substances was directly on the mechanism causing scald or whether it influenced the fruits' susceptibility to scald indirectly, e.g. by an effect on ripening, is not yet clear.

# **Preharvest Drop**

For the grower and store operator, the use of growth substances most likely to affect storage quality indirectly is the "cling-spray" to prevent preharvest drop. This is one of the most important applications of growth substances to horticulture, particularly in apples and pears, and has been reviewed recently by Vyvyan (1946). Normally  $\alpha$ -naphthalene acetic acid has been used but recently there has been increasing interest in the use of 2,4-dichlorophenoxyacetic acid in concentrations which are not injurious to the tree. It might be expected that the use of these substances on the tree would influence the rate of ripening or maturation of the fruit but investigations, particularly by the U.S.D.A. Field Station at Wenatchee, Washington, have shown that the direct effect on rate of maturation is slight compared with the tendency to have fruits too mature due to keeping them too long on the tree. There is a tendency for growers to leave the fruit longer on the trees, sometimes to obtain better size or better colour in blushed varieties. It is not always recognized that this leads to increase in the maturity of the fruit and that this is frequently accompanied by decrease in keeping quality. Even if the picking date is not delayed, there may be an increase in the percentage of fruits of advanced maturity and hence of poorer keeping quality; this is due to the fact that fruits which tend to drop early are probably frequently those of more advanced maturity. Thus. if fruit is required for long storage, the maturity factor must be examined carefully when sprays to prevent preharvest drop have been used.

### Fruit Size

The effect of growth substances on size is also related to the length of time that the fruit is kept on the tree before it drops naturally. There is some danger that increased size, obtained by the use of growth substances may be at the expense of keeping quality. There is evidence, however, that there may be a place for hormones to increase size. Thus Mitchell and Marth have shown that with the use of orthochloracetic acid or  $\beta$ -naphthoxyacetic acid, it is possible to increase the size of

blackberry fruits, and there was no evidence of reduction of storage life. On the other hand,  $\beta$ -naphthaleneacetic acid, by causing the fruits to hang longer, resulted in overmaturity and reduced storage life. Stewart and Klotz (1947) have shown that the use of 2,4-dichlorophenoxyacetic acid can increase the average size of Valencia oranges by about one commercial size class. Since fruit size in general depends largely on cell enlargement and growth substances greatly influence cell enlargement, the use of growth substances for control of fruit size may be an important field for further investigation.

## Blossom Thinning: Control of Crop Size

In addition to the relation of fruit size to keeping quality, size of crop has a marked influence, fruits from light crops being of poorer storage quality than those from heavy crops. Measures which will lead to control of crop size are therefore of interest in storage problems, particularly in districts where biennial bearing is marked. Growth substances have been used successfully in experimental spraying for blossom thinning. One of the difficulties in chemical blossom thinning is to perfect a technique which achieves the desired degree of thinning. When there is a chance of adverse weather conditions diminishing the normal setting, early artificial thinning may lead to a crop of less size than that desired.  $\alpha$ -Naphthaleneacetic acid has the advantage that it can be used for deblossoming at a time when the natural set is no longer in doubt. In spite of a few successful experiments, this technique has not yet led to practical recommendations; it seems necessary to carry out small-scale tests on each variety in each environment before application on any scale.

# Fruit Setting

One important use is the formation of fruits without pollination; in these parthenocarpic fruits the seeds are not developed. So far only a limited range of commercial fruits have been successfully treated, and of these the tomato, which is undoubtedly the most important, has received most attention. In some places treatment with growth substances is the only way of obtaining a tomato crop; this applies for instance to the State of Michigan, in which night temperatures, which frequently fall below 50° F., prevent normal pollination. Other successful applications have been achieved with strawberries, blackberries, pineapples and a number of fruits of minor importance; a number of attempts to obtain a suitable substance for apples has been unsuccessful.

Little work has been done on the storage and ripening characteristics of parthenocarpic fruit compared with those of fruits produced by normal pollination. The report by Gustafson (1942) that the parthenocarpic fruits are larger than the normal fruits suggests that this might require investigation. Differences in chemical composition have been reported by several workers; parthenocarpic tomato fruits tend to be higher in sugar and lower in acid, but ascorbic acid content appears to be about the same (see Pearse, 1948). Growth studies of normal and parthenocarpic fruits have been done by Clendenning (1948).

#### Conclusion

At least one growth substance is of direct practical application to fruit and vegetable storage problems, i.e. methyl  $\alpha$ -naphthalene acetic acid in the anti-sprouting treatment in potatoes. Other direct uses of growth substances have introduced interesting possibilities in the experimental stage but have not yet reached the stage of practicable recommendations. At present it is desirable for growers and store operators to be aware of the indirect effects of hormone treatments. Of these, the most important is the tendency of users of cling sprays to retain fruit on the tree to sizes or maturities which detract from its keeping quality. There is also the possibility that such substances used frequently on perennial plants may in time accumulate sufficiently to cause undesirable effects on their growth and development. Much more work is necessary to explore further both the direct and indirect effects of these active substances.

# References

BROWN, W. (1947).—Ann. Appl. Biol. 34: 422.
CLENDENNING, K. A. (1948).—Canad. J. Res., Sect. C. 26: 507.
DOWNIE, W. A. (1949).—J. Dept. Agric. Vic. 47: 301.
GUSTAFSON, F. G. (1942).—Bot. Rev. 8: 599.
MITCHELL, J. W., and MARTH, P. C. (1944).—Bot. Gaz. 106: 199
SCHOMER, M. A., and MARTH, P. C. (1945).—Bot. Gaz. 107: 284.
STEWART, W. S., and KLOTZ, L. J. (1947).—Bot. Gaz. 109: 150.
VYVYAN, M. C. (1946).—Gr. Brit. C'wealth Bur. Hort. Plant. Crops, Tech. Comm. 18.



# Some Bacteriological Considerations in the Handling of Food<sup>\*</sup>

By W. J. Scott

Bacteriological problems in the handling and storage of food should be considered firstly, from the viewpoint of protecting the consumer against food-borne disease and, secondly, in terms of preserving the food from spoilage by micro-organisms. The first aspect naturally assumes greatest importance in those foods which may be consumed as purchased or after only light cooking processes which are insufficient to destroy the disease-producing organisms or their toxins. The second aspect is obviously of greatest significance in those foods which are recognized as perishable at ordinary temperatures.

Both the public health and the food spoilage aspects may be considered in three main ways. Firstly, there is the question of the initial contamination of the food and, in this instance, it is important to know what are the numbers and types of micro-organisms present. Secondly, the influence of any processing treatments is important in so far as these treatments affect the numbers and types of bacteria in the food. Some processing treatments may confer additional contamination whereas others, such as pasteurization, may cause destruction of most of the organisms present initially. Thirdly, it is important to know the type of changes which the micro-organisms undergo during short or long periods of storage. Do the numbers during storage tend to increase, remain unchanged or decrease, and are some types more likely to change than others? When changes occur it is important to know the rate at which such changes take place. Some practical examples may be taken to illustrate problems under the above three headings.

Initial contamination is obviously of vital importance in some foods which may be exposed to contact with persons who may be carriers of pathogenic bacteria such as members of the Salmonella group. Contamination with small numbers of virulent organisms may be highly dangerous. From the point of view of keeping quality the extent of contamination with *spoilage* organisms is of greatest importance. The effect of variation in numbers is best considered in relation to the way in which bacteria reproduce. As each bacterial cell divides into two daughter cells, the population doubles and thus, as often as this occurs, the descendants increase in the ratio 1:2:4:8:16:32, etc. After dividing 10 times, one cell would have produced over 1000 descendants, and after 20 generations over 1,000,000. If we consider the surface of fresh meat with a contamination of 50,000 bacteria per sq. cm., we may say that the population will need to increase 1000-fold to 50,000,000 per sq. cm. before the surface carries a detectable slime. This increase, as we have seen, can occur in 10 generations. Now if the initial contamination is reduced to one-half, i.e. to 25,000 per sq. cm., it will now require II generations before the slime point is reached. In other words, in this particular case a 50 per cent. reduction in contamination would only bring about a 10 per cent, increase in the storage life. In a similar way it may be calculated that to increase the storage life by 50 per cent. we would need to reduce the contamination to about 1500 per sq. cm.,

\* Summary of lecture given to a meeting of District Health Inspectors, Newcastle, May 13, 1949.

4I

and to double the storage life the initial population would need to be reduced to about 50 per sq. cm.

Changes due to processing may also be considered similarly, the effect on the storage life depending on the factor or ratio by which the contamination is changed. For instance, if pasteurization of milk causes a reduction from 500,000 to 5000 per ml., this 99 per cent. reduction can be regarded as increasing the storage life by about  $6\frac{1}{2}$  generations. The effects of processing may, of course, be complicated by some organisms being affected more than others. Milk pasteurization is, of course, especially designed to destroy tubercle bacteria and it is also well known that spoilage by non-souring organisms is common in pasteurized milk, in contrast to the normal souring which develops in the unpasteurized product. When bacteria are destroyed by heat it should always be remembered that a certain time is always required at each temperature. Most non-sporing bacteria are destroyed at 140° to 145° F. within 30 minutes, or within a few seconds at 150° to 160° F. When it is necessary to destroy bacterial spores, as in the canning of foods, much greater heating is required. Sterilizing schedules for canned foods are generally equivalent to several hours at 212° F., although the processing is usually carried out at 240-250° F. at which temperatures heating for a few minutes is sufficient. These temperatures must, of course, be realized in the foodstuff itself.

Bacteriological changes during storage are also dependent on time and temperature. For instance, the slow death of bacteria in foods such as dried milk occurs more rapidly at high temperatures, and the rate of decline in bacterial numbers during frozen storage is decreased by lowering the storage temperature. Of rather greater practical importance, however, is a knowledge of the rate of growth of various bacteria in relation to temperature. If we return to the earlier example of meat surfaces contaminated with 50,000 bacteria per sq. cm., we may consider its storage life in relation to the rate of growth of the bacteria present. For a permissible 1000-fold increase, the storage life of 10 generations would be equal to to hours if the bacterial cells were able to divide once an hour, and 10 days if division took place every 24 hours. Some of the most active meat spoilage organisms have generation times around  $\frac{3}{4}$  hour at 80° F., I hour at 70°,  $1\frac{1}{2}$  hours at 60°,  $2\frac{3}{4}$  hours at 50°, 5 hours at 40°, and 12 hours at 30° F. The effects of small changes in temperature are much more important at low temperatures. For example, lowering the temperature from 80 to 70° F. would increase the safe keeping time by about 30 per cent., and from 40 to 30° F. would increase it by about 250 per cent. Food poisoning types of bacteria do not grow well at low temperatures and, in fact, there is little chance of food poisoning types growing on foods which are stored at temperatures of 50° F. or less.

We may summarize by saying that the four main lines of attack in improving the bacteriological quality of foods are (1) control of initial contamination, (2) avoidance of contamination with pathogenic organisms especially from human disease carriers, (3) use of processing methods which will reduce contamination as far as practicable, (4) ensuring that changes during storage are controlled sufficiently to give a reasonable margin of safety for whatever storage periods may be necessary.

It will be realized that many of the factors which affect the keeping quality of various foods have not been mentioned in this talk. Widespread application of the principles mentioned above will, however, contribute a great deal to improved bacteriological standards of our foods.

# Berry Fruit Juices\*

# $\mathbf{B}\mathbf{y}$

# J. F. Kefford

There are a number of possibilities for the production of attractive and nutritionally valuable food products from the juices of berry fruits, because they combine three very desirable characteristics. They have rich, natural colours and highly palatable flavours, and they are good sources of vitamin C. Strawberries contain as much vitamin C as oranges; raspberries and blackberries contain rather less, while blackcurrants are particularly rich, having three to four times as much vitamin C as citrus fruits.

Because they are less sweet and more acid than most fruit juices, and because of their high colour and intense flavour, berry juices are best used in blends, with other juices or with syrups, rather than as "straight" beverages. In America, a blend of apple juice with about 25 per cent. of raspberry juice has been well received, and we have prepared in our Homebush laboratories attractive blends of apple juice with boysenberry and youngberry juices (Menzies and Kefford, 1949).

Cordials and milk bar syrups, flavoured with strawberry and raspberry juices, are familiar products, but the amounts of berry juice they contain are small. The minimum Pure Food Act requirements vary between 12<sup>1</sup>/<sub>2</sub> and 25 per cent. In England a blackcurrant syrup containing about 40 per cent. of blackcurrant juice is being manufactured and marketed as a pharmaceutical line. It has achieved great popularity as a palatable source of vitamin C for children, and for adults suffering from digestive disorders. No less a person than the Chancellor of the Exchequer, Sir Stafford Cripps, is reported to have said that he depends upon this blackcurrant syrup to keep him going. The vitamin C content of the product is standardized to 80 milligrams per cent., which is about twice that of the average orange juice. During the war years a very similar blackcurrant syrup was canned in Tasmania and supplied to Australian and allied troops in the Pacific as an antiscorbutic. In future seasons it is likely that Tasmania will supply some of the blackcurrant pulp which forms the raw material for the British product,

Another possibility in the utilization of berry fruits is the manufacture of jelly juices (Cruess, 1949). Many housewives know that berry and currant jellies are colourful and flavour-full products much to be preferred to jams because they are free from those annoying pips and skins. But pressing out berry juices for preparing home-made jellies is a hot and messy business. The way is open for an enterprising manufacturer to put on the market packaged berry juices, standardized in pectin and acid content and requiring only the addition of sugar and a short boil to produce firm jellies, even in the hands of inexperienced cooks.

This brings me to the point of discussing what is involved in the manufacture of the products that I have described (Tressler, Joslyn and Marsh, 1939; Charley and Harrison, 1939). As with all processed foods, the story must commence with the raw materials—berry fruits.

\* From the script of a broadcast talk given in the Australian Broadcasting Commission's Country Hour on Monday, July 25th, 1949.

In Australia, berry growing is chiefly concentrated in southern Tasmania. where the annual crop of 7000 tons represents 90 per cent. of the total Commonwealth production. The Tasmanian crop consists mainly of raspherries and black and red currants, together with smaller proportions of strawberries, loganberries, blackberries and other varieties. Southern Victoria is the next most important area, with a similar range of production on a much reduced scale. The small plantings in New South Wales include some boysenberries and youngberries, and there is a developing strawberry industry in Queensland. We do not have the cranberries and blueberries that are popular items in the American diet, but then they do not grow blackcurrants. The quality of Tasmanian berry fruits is second to none in the world. But it is also true, unfortunately, that in harvesting and handling our berry fruits we go a long way towards ruining their initial high quality. Widespread improvements are necessary in methods of berry picking and berry pulp manufacture before it will be possible to say that the high quality of the fresh berries is carried over into processed berry foods.

Before the juice is extracted from berry fruits they receive a pretreatment involving either heating or freezing. Heating in steamjacketed pans to 175° F., with continuous stirring, crushes the berries and coagulates certain mucilaginous constituents which interfere with juice extraction. Freezing the berries is an even more effective preparation for juicing—it gives higher yields of juice of better quality. The American berry products industry is based exclusively on the use of fresh berries or berries frozen in cans or barrels, in contrast to the Australian industry, which uses mainly heat-treated pulps.

For expressing the juice from berry pulps the hydraulic rack and cloth press is the only satisfactory device, even though its operation is inevitably discontinuous and requires much hand labour. For small-scale juice extraction a handy hydraulic press can be constructed in wood and operated by means of a motor car jack.

Berry juices are most attractive in appearance when they are brilliantly clear, and this characteristic is achieved by a process of clarification. This process makes use of a preparation called pectinase, a product of the growth of moulds, those ubiquitous micro-organisms which are at the same time the friends and the foes of man. The pectinase treatment can be applied to the berry pulp before pressing, or to the extracted juice; but it would be omitted altogether in the preparation of jelly juices because the pectinase destroys the pectin that makes the jellies jel.

Clarification is completed by centrifuging and filtering and then the juice is ready for blending and filling into bottles or lacquered cans. A suitable blend would be: equal parts of berry juice and 15 per cent. sugar syrup, or one part of berry juice with three parts of apple juice. Lacquered cans are necessary because the clear red colour of berry juices becomes bluish and opaque in contact with bare tinplate.

Berry juices and blends are of course highly perishable products and they must be preserved by a pasteurization treatment, applied either before or after filling into containers. Continuous pasteurization for about one minute at 190° F. is one typical procedure, using equipment similar to that used for milk pasteurization. Alternatively the canned or bottled juice may be heated for 30 minutes at 180° F. For canned juices we are now recommending a process known as rotary pasteurization, in which the cans are rotated at 100 revolutions per minute in an atmosphere of steam. The rapid rotation agitates the juice in the can so that pasteurization is complete in two minutes. It is always desirable to reduce the heating period to a minimum in order to obtain maximum retention of colour, flavour and nutritive value. For the same reason it is most important to provide for rapid cooling after pasteurization.

In contrast to pasteurized products, berry juice cordials are preserved by the addition of a chemical preservative. A typical cordial has a sugar content between 50 and 60 per cent. and contains seven grains of benzoic acid or two grains of sulphur dioxide to the pint.

# References

CHARLEY, V. L. S., and HARRISON, T. H. J. (1939).—" Fruit Juices and Related Products." Imp. Bur. Hort., Tech. Comm. No. 11.

CRUESS, W. V. (1949).-West. Canner 41, No. 4: 57.

MENZIES, D. J., and KEFFORD, J. F. (1949).—Food Pres. Quart. 9: 31. TRESSLER, D. K., JOSLYN, M. A., and MARSH, G. L. (1939).—"Fruit and Vegetable Juices." Avi Publishing Co., New York.

# The Production of Tomato Pulp

# By

# G. GREETHEAD

# 1. Raw Material

Only fruit in good, ripe condition should be accepted at the cannery. Green fruit leads to poor colour in the finished pulp; only full-ripe fruit has the characteristic bright-red colour expected in tomatoes.

# 2. Washing

All fruit must be washed thoroughly to remove dirt, sand, etc., adhering to the fruit. This can be best accomplished by employing a soaking tank with a subsequent spray washing which will effectually reach every part of the surface of the tomatoes. The soaking tank, into which the fruit is dumped, should be provided with a good supply of water, overflowing at the end where most of the dirt and debris accumulates. A good flush cock is also necessary.

The soaking is necessary to soften any pieces of clay or soil adhering to the fruit and should be followed by thorough spray washing to remove the softened dirt. The washing is best carried out in a reel or "squirrelcage" washer fitted with water sprays operating under a pressure of not less than 50 lb./sq. in., and preferably of the order of 90 lb./sq. in. The spray-line should be placed about one foot above the fruit and the sprays directed at an angle of 45° so as to strike the tomatoes at the point where they roll over.

# 3. Inspection and Grading

Quality grading is perhaps the most important step in handling tomato products. It is essential that all material showing the slightest evidence of fracture, mouldiness or other deterioration should be removed after the washing stage. It is desirable that culled material should be trimmed as a separate operation as it is impossible for girls to inspect efficiently and trim at the same time. The sorters have to remove the objectionable tomatoes and have to work fast. The trimmers inspect the tomatoes removed by the sorters, dump those which are worthless and trim those which are valuable enough to warrant it. The inspection belt should be long enough to enable thorough inspection to be carried out. Removal of all mouldy material is essential as rigid standards for mould count are specified by the Department of Commerce, and failure of the product to meet these standards leads to rejection of a pack intended for export.

The trimmer should be provided with a sharp knife with a short blade. They should be informed that any rot that escapes their attention may be found in the finished product by microscopic examination. The trimmer cuts away any bad portions cutting a half-inch into the solid part of the tomato because moulds have a root-like growth that extends beyond the zone of active rot. The person in charge of the sorting belt should be shown the different forms of rot as they are found so that the sorters may be properly instructed. Good red ripe tomatoes properly washed and trimmed are the indispensable basis for any tomato product. For all tomato products except chili sauce, the next operation is pulping. From this point on very little can be done to improve quality. Quality may be lost subsequently through mishaps or mishandling, but it cannot be improved.

### 4. Hot or Cold Breaking

There is difference of opinion among successful tomato processors regarding the relative merits of cold-break and hot-break procedures. In the cold-break procedure the tomatoes are cycloned cold and a relatively large amount of air is included in the juice. The enzymes always present in tomatoes will bring about a change in the constituents if the juice is allowed to stand for even a few minutes before heating. These enzymes rapidly destroy the pectin which in a good pulp contributes to its thickness and favourable texture.

In the hot-break procedure, the preliminary heating given the tomatoes destroys the enzymes and protects the constituents susceptible to their action. With this procedure the tomatoes are crushed with a minimum inclusion of air and quickly heated to boiling point. The yield of cyclone juice is greater with the hot-break method, and the consistency is usually heavier owing to the higher pectin content. Somewhat greater care must be exercised in removing greenish tomatoes with the hot-break method, because cooking of the fruit before cycloning results in more of the objectionable colour from the greenish tomatoes being incorporated in the juice than is the case with a carefully controlled cold-break.

The typical procedure for both cold- and hot-break is detailed below.

## (a) Cold-break.

The fruit from the inspection and trimming tables is passed through a scalder, consisting of an endless belt passing through an enclosed box supplied with live steam from above and below the belt. The scalder has the function of loosening the skin so that the meat does not cling to it. The scalder may be omitted but the yield will be decreased and the pomace will have about 20 per cent. more moisture (which is tomato juice) than it would have were it properly scalded.

The scalded fruits are then passed through a grater or grinder to disintegrate them before passing through the pulpers. The preliminary grinding helps to prevent choking of the pulpers and permits a steady uninterrupted feed. If the tomatoes after pulping are run through a catsup finisher, a superior product is obtained, although the yield is slightly lessened.

#### (b) Hot-break.

The tomatoes from the inspection and trimming tables are dumped into large enamelled steel or stainless steel tanks. The tanks have concave bottoms with a large draw-off valve for emptying quickly. They are equipped with open steam lines, and as soon as the pipes are covered with tomatoes the steam is turned on and cooking is continued until all the tomatoes in the tank are disintegrated. The material is then run through two cyclones equipped with coarse and fine screens.

One of the main objections to hot-break is the large quantity of material on hand, with the risk of loss due to spoilage should a serious breakdown occur. Also the hot-break may introduce large quantities of condensed steam, particularly if the cookers are at a great distance from the boiler or the line not adequately "bled" or trapped. However, it yields a pulp of superior quality owing to its higher pectin content. This is particularly important if the pulp is to be used later for saucemaking.

An alternative hot-break system uses a continuous preheater, eliminating the main disadvantages of the batch system described above. The fruit from the inspection and trimming tables is passed through a grinder to partially disintegrate it and is then fed as quickly as possible into the preheater. This device takes the form of a long, steam-jacketed tube with a screw-conveyor running through it. The broken fruit is carried through by the conveyor and the rate of feed and steam supply are so arranged that the fruit reaches a temperature of 180° F. at the discharge end. This temperature is sufficient to cause destruction of the pectic enzymes and gives a juice of good consistency. The heated fruit is then passed through the cyclones as described above. This process, being continuous, eliminates the danger of heavy loss due to a breakdown and also prevents the dilution of the pulp with condensed steam.

# 5. Extracting

The juice extractor should be constructed of stainless steel and be capable of delivering the juice without aeration. The consistency of the juice will be governed by the quality of the raw material, the manner and degree of extraction.

# 6. Cooking

The cooking of tomato pulp is essentially an evaporative process, and except for the heat necessary to pasteurize the product the less heat treatment received during evaporation the better. Cooking is usually carried out in steam-jacketed kettles or in tanks heated by closed steam coils.

Jacketed kettles are usually made of copper and must be coated with tin on the inner surface. Stainless steel is a superior material for this equipment and should be used wherever possible. The steam supply to kettles must be generous, and drainage of the condensate must be adequate. Individual steam traps of a reliable type are recommended for installation on the drainage lines.

Tanks should be constructed of stainless steel and should be fitted with large outlets for rapid emptying. The heating coils should be sufficient to permit rapid reduction in volume of the pulp during cooking.

Care must be taken to avoid burning of the product during cooking. The steam jacket in pans or the coils in tanks should never be allowed to become exposed or burning will immediately follow, producing a poor quality product. The time necessary to complete a cook should not exceed 35 to 40 minutes, and should preferably be less to preserve best flavour and colour. Cooking is continued until the pulp reaches a concentration of not less than 6 per cent. soluble solids (see Standards, below).

# 7. Finishing

For pulp of the best consistency, the cooked material should be run through a pulp finisher before it is canned. This assures cleanliness, smoothness and uniformity, especially if any pulp clings to the cooker or kettle and is thick when the last runs out.

# 8. Filling and Sealing

Tomato pulp is usually packed in four-gallon cans, which are generally filled by hand, using a hose. Care must be taken to see that the closing temperature does not fall below  $180^{\circ}$  F. The cans should be filled to the top and any excess wiped off with a sponge or clean cloth kept in hot water. On no account should cool or cold pulp be added to top up the can, as this cool pulp may be contaminated and cause fermentation.

All four-gallon cans, whether new or old, should be tested for leaks before filling. With fair usage they can be refilled with pulp for two or three seasons. Old cans should be carefully inspected for pin-holes, bad seams, rustiness and cleanliness. If the holes are small and very few, they can be soldered and the can retested, but if the can is rusty on the inside it must not be used. Any pulp clinging to the cans, either inside or outside, must be washed off, or there will be grave danger of contaminating the fresh pulp when the cans are filled. All cans, old and new, must be washed thoroughly with water sprays and then steamed for one minute in order to heat and sterilize the cans. Never allow the cans to cool before filling.

The cans must be capped and sealed immediately after filling. The sealed cans should then be turned on their sides to sterilize the cap end. The person hauling the pulp away should inspect for leakers.

Pulp filled at  $190^{\circ}$  F. and closed at temperatures not lower than  $180^{\circ}$  F. will keep satisfactorily. If the closing temperature falls below  $180^{\circ}$  F. the pulp must be reheated.

# 9. Materials of Construction

Tomato products are adversely affected by the presence of a number of metals, particularly by copper and iron. The presence of either of these metals in the pulp causes darkening of the colour and greatly accelerates the destruction of ascorbic acid. Accordingly contact with either of these metals in the plant should be avoided. All copper equipment should be thoroughly tinned or silver-plated. Iron equipment should be avoided as far as possible. Galvanized pipes may be used for pumping, etc., but the zinc will be dissolved, and if much galvanized equipment is used the zinc content of the finished product may reach a toxic level. Tin-lined copper pipes are preferable but stainless steel or enamelled steel should be aimed at as the ideal.

All juice extractors, pumps, grinders, etc., should be constructed of stainless steel.

### 10. Plant Hygiene

Full provision should be made for the draining and flushing with hot water of all equipment at least twice daily. A cold water flush of all equipment before the morning start is also important. Juice extractor screens should be removed, and the equipment effectively hosed out; special attention being given to the worms and their supports. Centrifugal pumps should be dismantled and thoroughly cleansed at the end of the daily run. All pipe lines must be effectively flushed first with hot and then with cold water. All equipment should be left cold after the clean-up.

### 11. Standards

Examination of the pulp for conformity to accepted standards is carried out by a determination of soluble tomato solids and a measurement of numbers of moulds. Soluble tomato solids, on a salt-free basis, should be not less than 6 per cent., and moulds should not be present in more than 50 per cent. of microscopic fields. A full account of the techniques employed in these determinations will be found in the first two publications included in the list of acknowledgements.

# ACKNOWLEDGEMENTS

In preparing this report reference has been made to the following publications:

Association of Official Agricultural Chemists (1945).—" Official and tentative methods of analysis", p. 788. A.O.A.C.

Washington.

Australian Commonwealth Food Control, Dept. Commerce and Agriculture (1944).—" Canning of tomatoes and tomato products."

Bigelow, "W. D., Smith, H. R., and Greenleaf, C.A. (1941).—National Canners' Association Bulletin No. 27-L, "Tomato products".
Campbell, C. H. (1937).—"Campbell's Book ", pp. 417-442. Vance

Publishing Corp., New York.

# The Pickling and Canning of Olives

#### By

# P. THOMPSON

The processing of olives is necessary before they can be eaten, since the unprocessed fruit is intensely bitter. The bitterness has been found to be caused by a glucoside to which has been given the name "oleuropeen".

The bitterness is destroyed by dilute alkali at room temperature, and neutralization or removal of excess alkali does not cause a return of the bitterness. Treatment with dilute acid under pressure also removes the bitterness. In general, it is the former method, removal with sodium hydroxide, that is used.

#### Varieties

In American practice five varieties have been found suitable for commercial development: Mission, Ascolano, Sevillano, Manzanillo and Barouni.

The Mission is an excellent variety and is pre-eminent in vigour, productiveness, quality and suitability for processing. Its only fault lies in size, which seldom exceeds twelve-sixteenths of an inch diameter.

The Manzanillo is second in importance. It is slightly larger and ripens some two weeks earlier.

The Sevillano is third in importance. It is the largest of the commercially handled varieties, most of the fruit being larger than one inch in diameter.

The Ascolano is a large variety, but smaller than the Sevillano. It has a pleasing flavour and a crisp texture when processed.

The Barouni, also a large olive, has excellent processing qualities.

#### Harvesting

The olive matures slowly and consequently careful hand picking is necessary to obtain fruit of the correct maturity.

American packers have agreed to the following descriptions as defining the proper degree of maturity for ripe olives :

Mission: when of a straw colour to not more than red all over.

Manzanillo: when not more than half light red.

Sevillano: when not more than red.

Ascolano : when of straw colour and not more than a small blush of colour.

Barouni : when of a straw colour.

Any variety of olive shall be considered green if it will not yield milk under moderate pressure between the thumb and finger, and shall not be classed as a ripe olive.

Processing of olives results in the removal of most of the soluble compounds, so that the principal constituents of the finished product are olive oil and fibre. The relationship between oil content and colour (or degree of maturity) was established by G. A. Pitman of the University of California, and his table for the five standard varieties emphasizes the importance of maturity in selecting for good quality preserved olives. Fruit which is too ripe does not stand up to handling without injury to the appearance.

Variety.	Green.	Straw.	Pink.	Cherry.	Red.	Black.	
Ascolano Barouni Mission Sevillano Manzanillo	13.19 14.23 16.65 11.17 14.70	15.62 16.84 20.53 11.57 16.25	15.82 18.26 20.91 13.14 17.43	19·28 23·60 21·45 13·38 17·47	19.00 22.12 24.46 14.04 18.29	 22 · 75 16 · 06 18 · 40	

Percentage of Oil Present.

Fruit is picked into canvas buckets and carefully emptied into shallow lug boxes fitted with cleats which permit stacking of the boxes without bruising of the fruit.

# **Holding Solutions**

Where the capacity of the factory does not permit direct handling of the fruit, it is stored in what are termed "holding solutions". A solution of 5 to 10 per cent. brine is used in most factories. For periods of two weeks or greater a strong solution is necessary to prevent growth of mould and slime-forming organisms. A solution of 8 per cent. salt  $(32^{\circ} \text{ salometer})$  is satisfactory for Mission and Manzanillo varieties stored for longer than 10 to 15 days.

With Ascolano and Sevillano olives strong brines cause shrivelling and brines of 20° to 28° salometer are recommended with the necessary addition of edible lactic acid to the 20° brine to give a concentration of 0.5 per cent. acidity in order to prevent spoilage.

To avoid shrinkage in the olives, they should not be immersed immediately in 10 per cent. brine but placed in weak brine and salt added daily to build up the concentration to that required.

Care must be taken that deterioration does not occur during holding. Excessive bacterial growth may cause bleaching of the olives, and certain types of bacterial growth may result in the development of gas blisters a defect known as "fish-eye" spoilage.

This period in holding solutions is not essential but is recommended since a period of six weeks or longer in brine tends to harden the fruit tissue and render the subsequent action of the lye more uniform.

The salt concentration permits the development of only lactic acid fermentation which has a useful preservative action on the olives. If holding periods of more than six weeks are necessary, a concentration of 12 per cent. brine should be used and a covering of mineral oil to inhibit the growth of aerobic organisms which utilize lactic acid.

# Grading

Before the actual pickling operation is begun, it is customary to size grade the fruit. The machine generally used consists of moving diverging steel cables, very similar in design to an orange grader. Olive grades are designated in sixteenths of an inch, and the normal range for pickling is 10/16 to 17/16. Size grading before pickling is 'essential if uniform penetration of the lye is to be obtained.

Colour grading is also a useful step at this stage, since the riper fruit is more subject to lye injury than is the green. Separation into the three grades of black, cherry-red and green will avoid uneven lye treatment.

# **Pickling Vats**

Shallow vats are used for the pickling operations. They are usually constructed of concrete, and the dimensions are 8 feet by  $2\frac{1}{2}$  feet, with a depth of  $2\frac{1}{2}$  feet. Circular wooden tanks 6 feet in diameter and  $2\frac{1}{2}$  feet in depth are sometimes used, but concrete is usually preferred since it is less likely to become contaminated with bacteria and is consequently more easily cleaned.

# Pickling

# (a) First Lye Treatment.

The pickling process consists of several treatments with dilute lye. The first treatment is designed to intensity the colour, and does not assist materially in removing the bitterness.

In this treatment the lye concentration varies from 0.5 to 2 per cent., depending on the maturity and the variety of the fruit.

For Mission and Manzanillo varieties a solution of I to  $I \cdot 5$  per cent. caustic soda (sodium hydroxide) is used. For Sevillano and Ascolano varieties more dilute solutions are used due to the sensitivity of their colour to the action of lye.

It is usual to allow the lye in this treatment to penetrate to a depth of 1/16 of an inch below the skin. The rate of penetration is dependent on lye concentration and temperature of the bath. A temperature of  $60^{\circ}$  F. is considered satisfactory and penetration of 1.5 per cent. lye at this temperature takes approximately 6 hours, but may range between  $4\frac{1}{2}$  to 8 hours depending on maturity. Correct time is discerned by cutting and noting the change in colour, or testing with phenolphthalein indicator.

With dilute solutions (0.5 to 0.75 per cent.) up to 24 hours may be required. Generally the stronger solutions are favoured since penetration is more uniform.

Periodically during the processing the batch is stirred, either by paddle or compressed air. The latter is more common and the mixing avoids spotting caused by non-penetration of lye due to too intimate contact of the fruit.

#### (b) Exposure to Air.

When the skin has been penetrated to the required depth the lye is removed and the fruit exposed to the air. The length of exposure is usually two to four days, during which time the fruit becomes dark brown or black.

Agitation is necessary during the darkening process to ensure uniform colour in the finishing product. This mixing is accomplished by covering the fruit with water and stirring with compressed air for two to three minutes and then removing the water. This is repeated every three to six hours.

Some factories darken the fruit by holding in water, aerated by compressed air. The oxygen dissolved in the water accomplishes the darkening. This method results in fruit with flesh that is lighter in colour than olives darkened by exposure to air.

# (c) Subsequent Lye Treatment.

Usually three to four more lye treatments are used to cause further oxidation and completely eliminate the bitterness of the fruit.

A solution of 0.5 per cent. lye is applied for about four hours, being stirred periodically as in this first treatment. This may penetrate a third to one-half the depth to the pit. Washing and aeration as in the first treatment follows.

The procedure is similar for each following addition of lye (which should be of decreasing concentration) until the pit is reached.

The final lye treatment is then carried out to ensure complete removal of bitterness. A 0.5 per cent. solution is recommended for this final treatment.

The lye penetrates more quickly through the stem end and care must be taken that the lye treatment is not too prolonged or bleaching may occur.

The exact times suitable for the subsequent lye treatments must be determined from experience, but generally speaking weak solutions (say 0.25 per cent.) may be left for 24 hours while more concentrated solutions (e.g. 0.5 per cent.) may remain on the fruit for three or four hours.

Usually 24 hours separates each of the subsequent lye treatments.

# (d) Removal of Lye.

The residual lye is removed by leaching with water, and usually requires from five to seven days before its complete removal. Water is changed twice daily and agitation, either by paddle or compressed air, is periodically necessary. Continuous stirring completes the leaching in much less time.

Temperature is again important and 120° to 140° F. is recommended as fermentation is inhibited and extraction proceeds quickly.

Progress of the leaching operation may be followed by application of phenolphthalein indicator to the cut surface of the fruit. Taste may also be relied upon as an efficient indicator.

If colour is to be preserved during canning, a reduction of the pH to 7.5 is necessary. A suitable indicator to assist in gauging this point is phenol-red.

### (e) Curing in Dilute Brine.

When all lye is removed, the olives are cured by storing in a brine of about 2 per cent. (8° salometer) for about two days. This concentration is then increased over two to three days to 3 per cent. ( $12^\circ$  salometer). If held for more than a week after leaching, there is danger of bacterial contamination, softening or other troubles, so the canning operation is performed as soon as possible.

# Sorting and Grading

Before filling into the cans, the fruit is inspected and graded. The bitter fruit, recognized by its mottled colour at the blossom end, is removed and returned to the pickling vats. The remainder is graded for size and colour.

# Canning

In America special cans have been developed for olives, and are known as " tall pints " and " tall quarts ".

The usual fill-in weights are:

No. 10 packers' can	••	••		66 ounces
Tall quart olive cans	••		••	19 ounces
Tall pint olive cans	••	••	••	9 ounces
Buffet cans	••		••	5 ounces

The cans are lacquered to prevent bleaching of the fruit.

Boiling brine of  $2\frac{1}{2}$  or  $3\frac{1}{2}$  per cent. (10° or 14° salometer) is poured over the fruit and the cans are then exhausted to a centre temperature of 185° F., and after sealing are sterilized for 60 minutes at 240° F. and subsequently cooled.

In glass packing, caps are prevented from leaking by sterilizing and cooling in retorts filled with water under very high pressure. Fifteen to twenty pounds of air is admitted with the steam and the mixture kept in active circulation with open petcocks.

### Green Ripe Olives

In the canning of so-called green-ripe olives, several differences occur from the process detailed above for ripe olives.

Firstly the choice of variety is limited to the Manzanillo since the other varieties react unfavourably in one way or another to the different process.

The maturity most suitable for the green olive pack is attained when the colour is straw yellow rather than hard green.

Size grading is deferred till after lye treatment, since bruising and handling damage show up more easily in the lighter coloured fruit. Great care is therefore essential before lye treatment.

The lye treatment is somewhat different to that for ripe olives. Two alternative treatments have been found satisfactory :

- (a) One-lye Treatment : One treatment in 1.75 to 2.0 per cent. lye until penetration to the pit is accomplished gives good results.
- (b) Two-lye Treatment: Application of 1.75 to 2.0 per cent. first lye until half penetration, followed immediately by 0.75 to 1.0 per cent. lye for complete penetration gives good colour and texture.

Washing is also different, since the lye is not so readily leached as in the other treatments. Unless this lye is all removed, a soapy taste may develop in the product during retorting, caused by saponification of fatty substances in the fruit.

Two methods are used to remove the last traces of lye left after normal washing :

- (a) Pasteurize and allow to stand in vat to cool slowly.
- (b) Immerse in water acidified to a pH of  $4 \cdot 5-5$  with acetic acid. This process is slow (24 to 36 hours), and a second treatment may be required, although care is necessary to prevent a sour taste in the olives.

Generally a yellow colour is preferred, and if the pickled olives are too green they may be yellowed by heating to  $175^{\circ}$  to  $180^{\circ}$  F. in 0.2 per cent, acetic or lactic acid. The acid should be allowed to penetrate skin deep and the fruit should be washed immediately to remove excess acid from the flesh and to prevent mealiness after retorting.

Naturally, to preserve their attractive yellow colour plain cans are preferred, since yellow olives packed in lacquered cans darken appreciably during prolonged storage.

Processing is similar to the ordinary canned olive.

# Acknowledgements

In preparing this report frequent reference has been made to the following literature:

Bitting, A. W. (1937) .--- " Appertizing or the Art of Canning ", pp. 232-263. The Trade Pressroom, San Francisco.

Cruess, W. V. (1938).—" Commercial Fruit and Vegetable Products ",

pp. 179-192. McGraw-Hill Book Company Inc., New York. Cruess, W. V., and West, Nat (1940).—"Observations on Green Ripe Olives." Fruit Prod. J. 20: 115, 121.

Cruess, W. V. (1941).—" Olive Products." Ind. Eng. Chem. 33: 300-304.

Cruess, W. V. (1946).—" Advances in Olive Processing Methods in California and Abroad." Fruit Prod. J. 25: 237-241.

Orighi, A. L. (1943).—" Problems of Packing Ripe Olives in Glass." Canner 97, No. 20: 24-26, 40.

# Answers to Inquiries

# COLD STORAGE OF PORK

An inquirer wrote as follows : "We would like to obtain information concerning the cold storage of pork in a pile, as distinct from on the hook. We are aware that, by operating at a relatively low temperature, it is possible to pile meat, provided air space is provided between the carcases and temperatures are low enough to maintain the meat in a rigid condition. However, we have been unable to obtain information on the depth to which meat can be stacked under these conditions, or on the relationship between the chamber temperature and the depth of the stack. We have read that if the temperature is lower than 10° F. in the holding room, then a temperature of 14° F. in the freezing chamber should be low enough for bulk piling, but the depth of the stack was not stated."

The reply pointed out that initial freezing of pork in a stack is most undesirable and is not practised; and assumed that the question referred only to the subsequent period of frozen storage. The reply continued : "The primary consideration in the storage of pork is the control of onset of rancidity in the fat, and this condition dictates the storage temperature where storage is required for six months or more. For such periods of storage it is most desirable that the temperature be maintained at or below 5° F. Under these conditions pork in sides or carcases can be stacked, after freezing, to heights of up to 15 feet, without any appreciable distortion of the meat. We would not recommend a temperature in the range of ro<sup>°</sup> to 14<sup>°</sup> F., although at this temperature appreciable distortion should not occur in stacks of up to 10 feet in height. It is essential, of course, that floor dunnage be used in making such stacks."