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THE FUTURE OF DRIED EGG PRODUCTION.

By J. R. VICKERY.

The production of spray-dried egg powder in U.S.A., Canada, Argentina and Australia is now in excess of 150,000 tons per annum (equivalent to nearly 1,000 million dozen eggs), and it goes chiefly to the civilian population of Great Britain and to the Allied fighting forces, the U.S. Army alone taking about 30,000 tons. Five years ago, the amount of egg powder produced in these countries was negligible and the rapid growth of this new industry, despite early set-backs due to faulty processing and lack of experience in its utilisation, is a clear indication that dried egg is proving a valuable foodstuff for war-time needs by effecting considerable savings in freight space as compared with frozen pulp and by reason of its better keeping quality as compared with shell eggs. The essential role played by dried egg in war-time is attested to by the former British Minister of Food, Lord Woolton, who has stated,—"The supplies of milk and eggs arriving in this country in dehydrated form have helped to maintain a standard of feeding impossible in the last war."

Despite this war-time success, what are the prospects of marketing substantial quantities of egg powder after the war when shell eggs and frozen pulp again become freely available? While it is difficult confidently to predict what the future holds for this new commodity, guidance is afforded from a consideration of some technical data obtained during the past few years.

The minimum level of quality required in the powder will vary according to the use to which it is to be put. For domestic (household) use, only powder of the highest quality will suffice where the housewife will be using it for such delicate dishes as omelettes, scrambled egg and custard and for making sponge cakes. For manufacturer's use, a powder of good quality and high aerating power is needed for sponge cakes, but a somewhat lower quality will suffice for most other pastrycook's and baker's products.

Chemical and physical methods for assessing quality have been worked out and they are closely checked by a standardised tasting test. Briefly, these tests are designed to reveal mainly the degree of solubility, or dispersibility, of the powder and its freedom or otherwise from flat, stale, burnt or other off-flavours. Canada and U.S.A. have two grades. Grade A, suitable for all purposes, including domestic consumption, has a high degree of solubility and the flavour of the product reconstituted with water closely resembles fresh egg. Grade B, suitable for most manufacturing purposes, has a lower degree of solubility and may have a slight off-flavour. Australia recognises only one grade, the minimum standards for which are about intermediate between the American Grades, A and B.

While the preparation and handling of powder of Grade B standard is a relatively easy matter, the manufacture of powers consistently reaching Grade A standard calls for a high degree of skill in the design and operation of the drying plant. Such powders can be obtained only by meeting many requirements which include,—strict hygienic precautions in the preparation and handling of the pulp; careful balancing of the rate of spraying of the pulp, the inlet air temperature and the rate of air flow; use of a relatively low temperature in the input air (usually not exceeding 260 degrees F.); and rapid removal and cooling of the powder from the drying equipment. Overheating or too long an exposure to elevated temperatures results in a powder of low quality.

So far as storage is concerned, it is not sufficiently realised that egg powder is a rather perishable product and unless certain precautions are adopted even the best quality product will rapidly deteriorate below the standards required for Grade A or domestic quality. These precautions include the maintenance of a low moisture content (which should preferably not exceed 4 per cent), and holding at relatively low temperatures, certainly not exceeding 50 degrees F.

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if storage for more than a few months is contemplated. At high storage temperatures, around 80 degrees F. to 90 degrees F., such as are met with in tropical regions, the deterioration can be very rapid because of fast rates of loss of solubility and the acquiring of a burnt flavour. For instance, the quality grading of a powder stored at 86 degrees F. can fall from the minimum requirements for Grade A to the minima for Grade B in about two months.

Recently, however, Brooks and Hawthorne, of the Low Temperature Research Station, Cambridge, have reported (J.S.C.I. 62 (1943) p. 165) that the deterioration occurring at high storage temperatures is markedly retarded when certain carbohydrates are added to the pulp before drying. Milk sugar (lactose) and cane sugar, particularly the former, are effective for this purpose when concentrations of 10 per cent. in the pulp are added. Moreover, another advantage of the addition of these sugars is that the aerating power of the reconstituted powder is greatly improved, and this is most important when the powder is to be used as an ingredient of sponge cakes and similar baked products. It will be obvious, of course, that the use, as stabilisers, of relatively high proportions of sugars makes the product too sweet to be used in various straight egg dishes, such as scrambled egg, but since sugar is normally added to most baked products, the stabilised powder has considerable possibilities for general manufacturing and some household purposes.

In the post-war years, dried egg will have to compete with frozen pulp and shell eggs and its ability to do so will depend largely on the relationship of its price to that of pulp and shell eggs. An estimate of the possibilities can be made bearing in mind that one pound of powder is equivalent to three dozen eggs or about four pounds of pulp.

To be on a competitive basis, too, the operators of the egg drying plants must be able to produce powders of the desired quality and properties to suit the consumers, whether householders or manufacturers.

In the domestic market, only powder which, when reconstituted, approximates very closely to the pulp from fresh eggs will be satisfactory for straight egg dishes, and, as was pointed out previously, powders of such high quality are difficult to produce consistently. It is believed, however, that this market holds considerable prospects for a powder of good aerating power to be used by the housewife in such products as cakes, puddings, etc., during the autumn and early winter months when the prices of shell eggs always reach a maximum. For such uses, a stabilised powder of high aerating power (containing sugar) would seem to have the best prospects. Indeed, given a powder of guaranteed quality, it might well be used as widely in domestic cooking as is dried skim milk.

It seems unlikely that egg powder can supplant good quality frozen pulp in the larger units of the pastrycook and baking trades. The small manufacturers may find, however, that dried egg of high aerating power will be just as effective as frozen pulp and much easier to handle. Moreover, pulp when thawed, is highly perishable and must be used within 24 to 36 hours, and portions of tins are apt to be wasted through the onset of putrefaction if the small manufacturer's rate of output varies considerably. Another advantage is that the manufacturer does not need constantly to be ordering fresh supplies of egg pulp from the cold stores.

Prior to the war, considerable quantities of Chinese egg powder of rather poor quality, as judged by present standards, were used for manufacturing purposes, particularly in Great Britain and U.S.A. It seems likely that the superior product of the war-time plants will, in the post-war years, find its outlet in the same field, but its prospects of an expanding market to include sales to domestic consumers would be considerably helped by the production of a stabilised powder of good aerating power and keeping quality. For commercial outlets not desiring powder containing added sugar, good quality commercial grade powder would be available.

CANNED FISH LOAF.

By W. A. Empey and R. Allan.

Prior to the War canned Australian salmon had been produced in Australia. The product from this fish, which is not a true salmon, was generally rated as somewhat lower in quality than third-grade imported salmon. The most noticeable defects were toughness and dryness of the flesh and an unattractive colour.

Attempts to improve the palatability of the product were previously made by the C.S.I.R. Division of Fisheries, and reports of the investigations carried out are given in Fisheries Circular No. 2 (1940) and in the C.S.I.R. Journal Vol. 14 (1941) p. 47. The question of further improving the quality of the product was recently raised by the Australian Army and as the result of this, co-operative work was begun between the Divisions of Fisheries and of Food Preservation. The net result of these investigations was the production of a minced loaf-type pack which has proved acceptable to the Army and which has received favourable comment both from canners and consumers.

The methods and the materials used in the preparation of the pack are outlined in the following description.

Cleaning and Cutting.

After scaling, the whole fish are filleted and washed to remove any adhering scales or slime. There is no necessity to remove the small bones from the lugs, since these are broken up and softened during the subsequent cutting and processing. The skin is left intact, although it detracts to some extent from the appearance of the final product.

The fillets are cut up either in a mincer or a silent cutter. In the former, the fineness of subdivision can be regulated by the diameter of the plate holes. Excessive fineness is apt to produce too dense a texture in the product. A satisfactory texture is produced when plate holes of ¼ inch or ⅜ inch diameter are used. When a silent cutter is employed, texture can be controlled by regulating the number of rotations of the bowl beneath the cutting blades.

Mixing.

When the fish has been previously passed through a mincer, mixing is done in a paddle-operated mixer similar to that used for preparation of dough. In a silent cutter, mixing and cutting are done simultaneously. Water-soluble substances such as salt and colouring matter are conveniently dissolved in the water which is added to the mixture.

Composition of the Pack.

In addition to the fish the following materials have been included in various trial packs:—

Water, acetic acid, flour, mashed potato, minced onion, lard, beef dripping, peanut oil, tomato purée, curry powder, salt and colouring matter.

Amongst the numerous combinations tested, the following proved to be the most palatable according to the opinions expressed by a laboratory tasting panel and by various other persons:—

Fish	80 lb.
Flour (White Wheaten) or Proprietary preparation from white flour	8 lb.
Acetic Acid (1.5 per cent.)	1 gallon.
Peanut Oil	5 lb.
Salt	1¾ lb.
Colouring matter (Rhodamine B.S.)	1 gram ($\frac{1}{28}$ oz.)

Table vinegar diluted to contain 1.5 per cent. acetic acid may be used as a substitute for acetic acid.

Acceptable packs which are not quite so palatable may be produced by the exclusion of peanut oil and the substitution of water for acetic acid. On account of its relatively low oil content, the flesh of Australian Salmon is rather dry in texture apart from the characteristic toughness, and is improved by the addition of either an oil or a fat. Lard may be used, but does not blend so well as peanut oil. The inclusion of curry powder or tomato puree were not favoured, but the addition of mashed potato and of onion (10 per cent. by weight) resulted in attractive packs. Only 1 lb. of added water or acetic acid will be required when 10 lb. of onion are included in the formula.

With the exception of Kingfish, which proved a satisfactory substitute for Australian Salmon, other species of fish have not been tested, but there appears to be no reason why they could not be used. In the case of oily fish, the addition of an oil would not be necessary. A loaf made from equal parts by weight of salmon and veal proved very palatable although having a less pronounced fishy flavour.

Rhodamine B.S., the only edible colouring matter so far tested, imparts an attractive pink colour when used in the specified concentration. The dark pieces of skin detract somewhat from the colour of the loaf, but this could be eliminated by skinning the fillets before processing.

Processing.

The retort process required to sterilize the product will depend upon the type of cans being used. One pound squat cans (401 x 210) which are not heat exhausted, will require approximately 2 hours at 240° F.

Yield of Product.

In the case of full-sized salmon ranging between 5 and 6 lb. in weight, the approximate yield of product from 1 ton of raw whole fish, allowing a 60 per cent. loss due to filleting, is 1,170 lb. This yield is approximately the same as that obtained by current commercial canning methods.

Characteristics of the Product.

When prepared according to the stated formula the loaf produced is sliceable at ordinary air temperatures but will be firmer after storage in a refrigerator or an ice chest. Slices may be eaten cold or warmed by frying with a little melted fat. The consistency is satisfactory for fish rissoles, but egg yolk and bread crumbs may be added, if desired.

Summary.

Production of Australian Salmon in the form of canned fish loaf as described in this article provides a satisfactory method for preparing an acceptable product from a type of fish which is generally unpopular for use as fresh, frozen or smoked fish, or when canned by the usual methods.

SWEET POTATO VARIETIES FOR CANNING.

By J. F. Kefford.

In anticipation of Allied Service demands for canned sweet potatoes, canning trials were made of a number of sweet potato varieties grown in New South Wales. The New South Wales Department of Agriculture assisted by supplying or arranging the supply of many of the varieties tested. Other varieties were obtained through the Commonwealth Department of Commerce and Agriculture.

Canning Procedures.

Sweet potato canning has not been practised to any extent by Australian canners. The usual pack in the United States of America is a solid pack prepared by steaming the washed roots in retorts, peeling by hand and packing directly into cans, which require no exhaust if a closing temperature of 150-160° F. is achieved by prompt handling. Syrup packs, vacuum packs, pie packs and candied packs are also put up in America.

The varieties under test were canned, in the laboratory, in several styles:—Solid Pack, Whole Sweet Potatoes or Pieces in Sweet Brine, and Diced Sweet Potatoes in Brine. The latter two packs were tried since they conform to current vegetable canning practice; but in general these packs were unappealing. It is suggested that the solid pack is the most attractive form of presentation and most likely to meet anticipated requirements. The following procedure is recommended for solid pack sweet potatoes:—

Solid-Pack Sweet Potatoes.

Washing.—The roots are soaked in a dump tank, then washed under high-pressure sprays.

Grading.—Grading for size at this stage may facilitate subsequent handling.

The usual size grades are—

- Large—Diameter greater than 2 inches.
- Medium—Diameter 2 to 1¼ inches.
- Small—Diameter less than 1¼ inches.

Peeling.—As noted above, American practice is to steam the roots under pressure, after which the skins are slipped off by hand by operatives wearing cotton gloves, who fill directly into the cans. It is not likely that this method of handling will appeal to Australian canners.

Abrasion peeling and lye peeling (3 to 5 minutes in 5 per cent. to 10 per cent. caustic soda solution at the boiling point) were successfully applied in the present trials. Some hand trimming was necessary after peeling by these methods. Peeling losses were of the order of 30 per cent.

Steaming.—The peeled roots are placed in crates in shallow layers (*e.g.*, 6 inches deep) and steamed in retorts for approximately 10 minutes at 240° F. Large roots may require longer steaming. During steaming, contact of the roots with bare iron should be avoided. Iron contamination accentuates the tendency of sweet potatoes to develop black discolouration after heat treatment.

Filling.—Prompt handling of the steamed roots out of the retorts is necessary to achieve a satisfactory high closing temperature. The roots may be dumped on packing tables, filled rapidly into cans by hand and rammed down with a topping device to the correct fill. Mechanical filling in a plunger filler may be applicable to this pack.

Exhaust.—If a centre temperature of 150-160° F. is reached in the hot-filled cans at closing, no exhaust is necessary. Otherwise a short, hot exhaust is desirable. A high vacuum is essential in sweet potato packs to avoid black discolouration in the headspace region.

Process.—Processing schedules recommended by the National Canners Association for Solid Pack Sweet Potatoes are set out below:—

Can Size.	Initial Centre Temperature.	Retort Temperature.	Time.
No. 2 (307 x 409)	80° F.	240° F.	110 min.
	120° F.	240° F.	105 min.
	150° F.	240° F.	95 min.
	180° F.	240° F.	85 min.
No. 2½ (401 x 411)	80° F.	240° F.	130 min.
	120° F.	240° F.	120 min.
	150° F.	240° F.	110 min.
	180° F.	240° F.	95 min.

These are the minimum processes that can be used with safety.

Cooling.—Rapid cooling of the cans is desirable.

Black Discolouration in Sweet Potatoes.

Sweet potatoes exposed to the air after heating tend to discolour. Some varieties are particularly susceptible, and develop intense blackening after brief exposure; other varieties show only a slight tendency to darken. During processing discolouration largely disappears, but it may re-appear, particularly in the headspace region, if oxygen is not largely eliminated by the maintenance of a good vacuum. Contact with metallic iron or contamination with iron salts accelerates discolouration and tends to make it permanent, so that it does not disappear on subsequent reheating.

Good vacuum and freedom from iron contamination are essential for attractive colour in sweet potato packs.

Varieties Tested.

The eighteen varieties tested in the present trials were canned as received, without any preliminary curing or storage, although in most cases about two weeks elapsed between harvesting and canning. Most of the varieties were grown at the Grafton Experiment Farm of the New South Wales Department of Agriculuture, and the others by private growers.

Conclusions.

Porto Rico was outstanding in canning quality in the present trials, while an unnamed Porto Rico cross was also of high quality. White Yam, Yellow Strasburg, Nancy Hall, No. 1915 (Porto Rico cross) and "McDonald River Red" were indicated as fair canning varieties. Other varieties tested which are not recommended for canning purposes were:—Cuban Bush, No. 47442, No. 4528-19, Farmers' Special, H.A.C. Pink, Cox's Pink, White Maltese, Russian 85, Cuban White, Cuban Red, and one unknown variety.

SUGAR INVERSION IN JAM MAKING.

By F. E. Huelin.

The process of jam making consists essentially in boiling fruit with cane sugar until the fruit is sufficiently cooked and the product is sufficiently concentrated to set on cooling and keep subsequently without deterioration. The details vary with each jam, depending on the time required for cooking and the physical structure of the product. With plums, a few minutes boiling with a minimum of water reduces them to a fine pulp, from which the stones can be readily removed. The pulp can then be boiled with sugar and concentrated to a suitable level of solids (66-71 per cent. by refractometer) in less than ten minutes, using steam-jacketed copper pans. On the other hand, marmalade consists of shreds of citrus rind embedded in a jelly, and requires a fairly prolonged boil (at least an hour) to make the rind sufficiently soft. The final boil with sugar should be sufficiently prolonged to allow adequate penetration of the sugar into the pieces of rind.

In addition, the degree of sugar inversion has to be taken into consideration. Cane sugar (sucrose) is a non-reducing sugar (*i.e.*, it does not reduce Fehling's solution), but on boiling with acid it is converted into two reducing sugars, glucose and fructose. This change is known as inversion, and the mixture of glucose and fructose is called invert sugar. Reducing sugars are present in the fruit, but usually these account for only 5-10 per cent. of the total sugar, and larger amounts must come from inversion of the added cane sugar. The rate of inversion is determined by the hydrogen-ion concentration or active acidity, which is usually expressed in terms of pH. The lower the pH the greater the acidity and the more rapid the inversion. pH is also a critical factor in setting. If it is too high, the jam fails to set, and, if it is too low, "weeping" with exudation of syrup may occur subsequently. The range of pH from 3.0 to 3.5 is the most suitable for jam making.

The degree of inversion (*i.e.*, percentage of total sugar inverted) is important in the final jam, in order to eliminate crystallisation. If the cane sugar is partly inverted, there is less risk of crystallisation than if none or all is inverted. This is due to the fact that a mixture of the three sugars is more soluble than cane sugar or invert sugar alone. Negligible inversion may result in crystallisation of cane sugar and complete inversion in separation of glucose. If from 30 to 50 per cent. of the total sugar is inverted, the risk of crystallisation is reduced to a minimum.

A prevalent idea is that sugar inversion is detrimental to jelly formation, and that cane sugar is essential for jellying. This has been disproved by Cole, Cox, and Joseph (Food Industries, May, 1930), who prepared excellent jellies with invert sugar. Jelly formation was retarded, but the final jellies were as firm as those prepared with cane sugar, and did not exhibit any more "weeping." These workers pointed out that many American manufacturers make high-quality jellies from invert sugar. The idea has probably arisen because poor setting and a high degree of inversion may result from excessive boiling. It is, however, the degradation of pectin and not the inversion of sugar, that reduces the jellying power.

Obtaining Sufficient Inversion.

The required degree of inversion should be obtained by approximately ten minutes boiling at pH 3.0 and about 30 minutes boiling at pH 3.5. A much shorter boil is often adequate for cooking the fruit and concentrating to setting point, with the result that boiling would have to be deliberately prolonged to obtain sufficient inversion. This could be avoided by replacing part of the cane sugar *with a pre-inverted syrup*. A suitable invert syrup can be prepared by boiling cane sugar with 0.05 per cent. of sulphuric acid for 15 minutes. No more than this concentration of acid should be used, and it should preferably be neutralised after boiling.

Some fruits are rather deficient in acid, and citric acid or lemon juice is required to bring the pH of the jam to 3.6 or below, which is essential for setting. In this case, some preliminary inversion may be obtained by boiling the sugar for about a minute with the citric acid or lemon juice before adding the fruit. In the absence of the fruit buffers, the acid may reduce the pH of the syrup to about 2.5, and accelerate the inversion considerably.

Control of Inversion.

The degree of inversion of syrup or jam may be determined approximately as follows:—Determine total solids with a refractometer, correcting for temperature. (About 95 per cent. of the total solids in a jam is sugar.) *To determine reducing* sugar, digest 10 grams of jam with hot water and make up to 500 ml. Filter if necessary. Take 10 ml. of mixed Fehling's solution (5 ml. of solution A and 5 ml. of solution B), dilute to 50 ml. and bring to the boil. Titrate the diluted jam into the boiling solution until the blue colour of the Fehling's solution is nearly discharged. Then add two drops of 1 per cent. methylene blue solution and continue the titration until the blue colour is completely discharged.

10 ml. of mixed Fehling's solution is approximately equivalent to 0.05 grams *of reducing* sugar.

$$\text{Invert sugar (per cent.)} = 250/\text{titration}.$$

$$\text{Degree of inversion (per cent.)} = \frac{\text{Invert sugar}}{\text{Total solids}} \times 100.$$

Fehling's solution A contains 69.28 grams of pure crystallised copper sulphate in one litre.

Fehling's solution B contains 350 grams of Rochelle salt and 120 grams of pure sodium hydroxide in one litre.

SOLID JAMS.

By F. E. Huelin.

An account of the preparation and handling of solid jams has already been given in a previous issue of the "Food Preservation Quarterly" (vol. 3, No. 2). This article described the preparation of solid plum and raspberry jam, using concentrated pectin extracts from apple residues. The preparation and testing of these extracts was also described.

Subsequently, solid quince jam and "marmalade mixture" have been prepared and further storage tests carried out. Attempts to prepare solid apricot and peach jam have not been successful. The information is outlined briefly in the following paragraphs.

Preparation of Pectin Extracts.

Concentrated pectin extracts can be obtained from apple or citrus residues. Apple residues include pomace from juice pressing and skins and cores from canning and dehydration plants. Citrus residues consist of skins and rag from juice-pressing plants. The material is first leached in running water, preferably in a tank with a perforated false bottom, until the specific gravity of the effluent is not more than 1.0005. Dried material should first be soaked in cold water for 30 minutes.

After pressing, the leached residues are boiled for 40 minutes with a quantity of dilute citric acid solution equivalent to 2-2.5 times the weight of the wet residues and 8-10 times the weight of the dried residues. About 0.1-0.2 per cent. of citric acid is required for apple residues and 0.5 per cent. for citrus residues (to make the pH of extraction 3.0-3.5). The extract is then pressed out in a rack-and-cloth press, strained, and concentrated *in vacuo* to 5 per cent. pectin (as indicated by a jelly test). Details of the testing of pectin extracts were given in the previous article.

One difficulty in the above procedure is the use of appreciable quantities of citric acid, which is not readily available. Mineral acid, *e.g.*, N/50 hydrochloric acid, gives equally good extraction, but its use would not be permitted in any extract which is added direct to the jam. Mineral acid could be readily used in the preparation of solid pectin, where this is separated from the extract by precipitation, but the manufacture of this product involves an elaborate procedure requiring considerable technical resources.

Preparation of Solid Jams.

The jams are prepared by boiling the fruit pulp with sugar in the usual way and adding the pectin towards the end of the boil (to avoid destruction). It is advisable to take a much greater proportion of pulp to sugar than is usual in ordinary jam, and in this laboratory the solid jams were prepared by boiling 150-200 parts of pulp with 100 parts of sugar.

The jams should be boiled down to 70-75 per cent. solids (finishing temperature 223° F.). They should then be poured without delay into trays, as they set rapidly. After setting they are cut up into 1 lb. blocks, which can be wrapped in waxed paper and packed in suitable cases.

The solid quince jam has an excellent flavour and should be quite acceptable as a confection. About 20 parts of 5 per cent. pectin (per 100 of sugar) and an additional 1.6 parts of citric acid are required in its preparation. The citric acid is necessary to bring the final pH to 3.2-3.4, which is the optimum for setting.

Solid plum and raspberry jams require about 40 and 50 parts of 5 per cent. pectin (per 100 of sugar), respectively. The fruits themselves are usually sufficiently acid.

The solid "marmalade mixture" is adapted from a commercial product which is made almost entirely from citrus (mainly orange) residues. It is made from a mixed pulp containing about three parts of skin pulp to one part of screened rag pulp and a small amount of lemon pulp. One hundred parts of mixed pulp are equivalent to about 30 parts of citrus residues. Fifty parts of 5 per cent. pectin (per 100 of sugar) and about 0.9 parts of additional citric acid are required in the preparation of solid "marmalade mixture."

In this laboratory, pectin extracts from apple residues were used in the preparation of solid quince, plum and raspberry jams. In the "marmalade mixture" extracts from citrus residues were used. These extracts, together with the original pulp, contributed to give a somewhat bitter product, tasting rather too strongly of orange skin.

Storage.

Under conditions corresponding to those in Southern Australia, *i.e.*, 68° F., 70 per cent. humidity, and laboratory temperatures at Homebush, the wrapped blocks keep satisfactorily for three months with only slight "weeping" and crystallisation on the surface. Longer periods of storage result in decided surface crystallisation.

The jams keep almost as well at 86° F. for three months, provided the humidity is low (70 per cent. or less). At 86° F., 85 per cent humidity, which approximates to tropical conditions, mould develops rapidly on the surface of the blocks.

Use.

The jams prepared by the above procedure are too firm to be spread satisfactorily, but can be broken down with water and sugar to give a product more like an ordinary jam. One part by weight of water and two parts of sugar to one of the original jam gives a product of suitable consistency. The solid jam is cut into small pieces and soaked in the water overnight. After bringing to the boil, the sugar is added, and boiling continued for about two minutes.

The above procedure involves a considerable dilution of flavour, which is particularly noticeable in the quince. The other jams still retain a reasonable flavour after dilution.

To avoid breaking down, solid jams of weaker consistency could be prepared by using about 20 parts less pectin extract (per 100 of sugar). Such jams could still be cut up and wrapped readily, but might break and lose their shape a little more easily during handling and would have a greater tendency to "weeping."

CANNING OF CHICKEN.

By W. A. Empey.

The following description outlines methods for canning of chicken.

Feeding Prior to Killing.

Several American canneries make use of special feeding batteries with controlled ventilation, uniformity in temperature, and high humidity (using water sprays) in which the birds are fed to capacity twice daily. A period of twenty-hour hours' starvation with free access to water is allowed before slaughter.

Slaughter.

The birds, after killing, are bled for a short period while suspended on a moving conveyor. Slaughter by electrocution has also been practised in one United States cannery. By this method the chicken's head is placed in a holder attached to an endless chain conveyor. A trip switch turns on a high voltage (1,000 to 1,500 volts) low amperage current which stuns the birds immediately. A high-speed rotary knife makes a clean cut through the blood vessels of the neck.

After slaughter, the birds are transferred through subsequent stages by means of shackles attached to a chain conveyor.

Scalding.

Scalding by immersion for 15 to 20 seconds in vigorously agitated water at 126° to 130° F. gives excellent results with no detrimental effects on appearance or keeping quality.

Feather Removal.

Approximately 75 per cent. of the feathers, including all quills, are removed by hand. Power plucking machines are sometimes used. After passing through a long drying chamber at about 90° F., followed by slight cooling at room temperature, the carcases are coated with molten paraffin wax (115°–130° F.) held in a counter-weighted dip tank which is raised to completely immerse each bird. The birds are returned to the same tank a few seconds later to receive another coating. The carcases then enter a spray chamber for tempering by water sprays to produce a tough elastic wax film.

The wax is then stripped from the carcases, which are finally cleaned with high-pressure water sprays. For recovery of wax the wax-feather mass is conveyed to a reclaiming tank, where it is heated to 250° F. for removal of moisture prior to separation of feathers in a perforated centrifugal extractor. The wax loss averages 2 to 3 lb. per hundred birds.

Chilling.

The birds are cooled at about 36° F. for a minimum period of eight hours prior to evisceration. For holding periods exceeding one week it is preferable to freeze eviscerated birds.

Evisceration.

Any remaining pin feathers are removed by hand and fine hairs singed by a gas flame. Evisceration is carried out on a series of stainless steel conveyor tables with trays that are steam-sterilized during each trip around the circuit.

The viscera are drawn out through an incision in the posterior abdominal wall as the bird lies in its individual pan and the birds with attached viscera are examined by an inspector. The heads and feet are removed on a stainless steel receiver and the birds are transferred to the next eviscerating table.

The neck skin is slit and the neck removed before passing to the main eviscerating table, which has individual stalls for the eviscerating operation as well as a pan conveyor system similar to the inspection table. The viscera are carefully removed by girls working on individual stainless steel trays placed at the side of the conveyor, and upon which a stream of running water flows. The giblets are removed and kept separate. Rupturing of the intestines and gall bladder should be avoided.

The birds are returned to the conveyor and moved along to a washing tank, where high-pressure sprays are used to clean out the cavities. Surplus moisture is removed by draining.

Specially-designed machines are sometimes employed for cutting and removal of the necks, cutting the legs and evisceration.

The subsequent treatment prior to canning will depend upon the form in which the final product is required.

Roast Whole Chicken.

The legs and wings are tied in position and the birds lightly roasted in wire frames or in pans in a moderately hot oven for about 25 to 30 minutes. Basting every 3 minutes will preserve the best appearance and prevent surface drying. Prior to placing in cans the birds may be stuffed with heated dressing which is not pressed tightly enough to greatly interfere with subsequent treatment (heat penetration).

Boiled Whole Chicken.

Before placing in the can the chickens are precooked in boiling water in a jacketed kettle until the flesh shows some tenderness and the fat begins to collect on the water. When precooked under pressure less time will be required to produce the necessary degree of tenderness.

Boned Chicken.

Boned chicken may be used for the preparation of roasted or boiled pieces or for inclusion in such packs as spaghetti and chicken, ravioli paste, or chicken tamale.

The birds, together with 1 quart of water for each 25 lb. of meat, are placed in steel drums (with tightly-fitting lids) which fit into cooking retorts, and are given 15 to 30 minutes cooking at 15 pounds pressure (250° F.) in order to facilitate the removal of meat from the bones. Alternatively, cooking can be carried out in pressure kettles. Pressure pre-cooking has distinct advantages over the open-cook method, which requires a considerably longer period with a much larger volume of water.

The meat is then sorted out on to aluminium trays according to the use to which it is to be put. Special selection is made of the breasts, thighs and legs for the roast-chicken pack. These pieces are placed in electric ovens on trays, roasted, and the bones removed to obtain a solid pack. If boiled chicken pieces are required the preliminary roasting is omitted. The good quality boiled chicken pack contains equal parts by weight of meat and jelly.

Pre-cooked meat for other chicken products is packed into moulds and held at 32° F. for at least 3 hours for shaping, preparatory to slicing or other preparation. Grinders and slicers prepare the meat for other products such as spaghetti and chicken, ravioli paste, and chicken tamale. The feet, bones, necks, giblets and skin (if removed before packing) can be used for preparation of chicken soup.

Filling.

It is customary to fill the interstices of the pack with hot jelly, either 10 per cent. gelatin or 2½ per cent. agar. In the case of the boiled packs, gelatin or agar in the required concentration is dissolved in the strained pre-cooking liquor. When the open pre-cooking method is used it is necessary to concentrate the broth to slightly less than half of its original volume before filling the cans.

Gelatin is regarded as producing a better-flavoured jelly than agar but has the disadvantage of softness at summer temperatures. The grade of gelatin should be carefully chosen to avoid excessive hydrolysis and breakdown during retorting.

The necessary amount of salt may be added to the water used in pre-cooking or to the heated jelly before placing in the cans. The former method is recommended, since it facilitates the separation of fat. If the containers are promptly filled with hot jelly it may be possible to dispense with heat exhaust prior to closing.

Type of Containers.

Either tin cans or glass jars may be used. In the United States of America cans which are either oval or shaped to the form of the chicken are commonly used for whole birds, but these cans require special types of closing machines. Open-top cylindrical cans and glass jars are commonly used for boned chicken and for special mixtures and soups.

Equipment.

Apart from the special requirements for preparation up to the stage of filling the containers, the equipment needed will be similar to that usually employed in meat canning. In the absence of a vacuum closing machine an exhaust box will be required for those products which are insufficiently hot at the time of closing to ensure a satisfactory vacuum.

The retorts used should be provided with facilities for pressure-cooling.

Processing Times and Temperatures.

The processing times and temperatures required to produce a sterile pack will depend upon a number of factors, including the shape and size of the container, the weights of meat and jelly, and the temperature of the contents when retorting is commenced.

At a temperature of 240° F. the time required for processing a 1 lb. can (401 x 211) containing closely-packed meat at a commencing temperature of 70° F. would be approximately 120 minutes, while the corresponding time when the commencing temperature is 130° F. would be about 100 minutes. The time required for the less solid packs containing a greater proportion of jelly will be shorter.

Processing schedules recommended by the National Canners Association are set out below:—

Can Size.	Initial Temperature.	Retort Temperature.	Process Time.
303 x 406	70° F.	240° F.	100 min.
	130° F.	240° F.	90 min.
	70° F.	245° F.	85 min.
	130° F.	245° F.	80 min.
	70° F.	250° F.	75 min.
	130° F.	250° F.	70 min.
404 x 414	70° F.	240° F.	150 min.
	130° F.	240° F.	130 min.
	70° F.	245° F.	130 min.
	130° F.	245° F.	115 min.
	70° F.	250° F.	115 min.
	130° F.	250° F.	105 min.

References on Chicken Canning.

In preparing these notes the following articles, several of which contain illustrations of equipment and processing procedure, have been consulted.

Poultry Packers Put Quality Under Control—Food Industries, Vol. 10 (1938), p. 489, p. 559.

A New Canned Product—Food Manufacture, Vol. 8 (1933), p. 58.

Creates Popular Products from Unwanted Surplus—Food Industries, Vol 11 (1939), p. 378.

Efficient Straight-line Production Depends on Conveyors—Food Industries, Vol. 3 (1931), p. 62.

Whole Chicken Packed in Glass—Canning Age, Vol.11 (1930), p. 643.

Canning Chicken—Canning Age, Vol. 11 (1930), p. 334.

British Poultry Canning—Food Manufacture, Vol. 8 (1933), p. 325.

Poultry Marketing Method—Ice and Cold Storage, Vol. 40 (1930), p. 73.

Wax Cleaning of Poultry—Refrig. Eng., Vol. 37 (1940), p. 229.

HEADSPACE, INTERNAL CAPACITY AND DENSITY DETERMINATION IN CANNED SOLID PACKS.

An Application of Nicholson's Hydrometer.

By R. S. Mitchell.

The determination of headspace in cans of solid products, such as corned beef or mutton, meat loaves, processed cheese, butter, tropical spread, etc., is rarely satisfactory by the usual methods employed for packs in liquid media. The surfaces of solid packs are often irregular and the headspace may be located haphazardly in the can.

Thus the conventional procedure of measuring the depth of the headspace from a straight edge laid across the top of the can to the surface of the product is not applicable. For similar reasons and also because of the pronounced tendency for hollow puncture needles to block up in such products, the Campden manometer (1) is not satisfactory for determining headspace volumes in solid packs.

Nicholson's Hydrometer

To avoid these difficulties a different approach was made in this laboratory, involving the use of a Nicholson's hydrometer.

A large version of this well-known instrument was constructed from portion of a No. 10 can with a copper tube soldered at the centre of the upper end, supporting a platform for the sample, and with tinplate strips below carrying another platform suitably weighted with lead.

The application of the hydrometer is based on Archimedes Principle: that a body immersed in water shows a loss in weight equal to the weight of an equal volume of water. Nicholson's hydrometer provides a convenient method for weighing objects in air and in water. In its present usage in the examination of canned foods, the filled can, the empty can and the solid block of product are weighed in air, on the upper platform, and then when immersed in water, on the lower platform.

The loss of weight in water of the filled can less that of the empty can gives a measure of the *internal capacity* of the can. This internal volume less the volume of the contents gives a measure of the *headspace volume.* A flotation balance designed to measure the internal capacity of cans and based on the same principle has been described by Adam and Stanworth (2).

The *relative density* of the product may also be calculated from its measured weight and volume. This direct measurement of the density of the block of product as canned is valuable since bubbles and pockets or gas may appear in loaf packs, particularly if they are not mixed under vacuum.

The Nicholson's Hydrometer has proved to be particularly useful for guiding the selection of a size of can to contain a given weight of product, which will avoid both overfilling, with danger of subsequent springiness and distortion, and, on the other hand, an excessively large headspace.

One pound cans and smaller sizes are readily examined with the hydrometer described, and it has been used even for 6 lb. tapers by measuring the weight in air on ordinary scales. The method is applicable to packs lighter than water, *e.g.,* butter, tropical spread, provided steps are taken to prevent the block from floating off the lower platform when it is submerged.

In a specific case which was investigated, a high proportion of springy cans had been encountered in 12 ounce processed cheese packs from certain manufacturers. No evidence of microbial deterioration could be discovered, but application of the Nicholson's hydrometer techniques gave the results set out in the table.

Manufacturer.	Can Size.	Condition of Cans.	Capacity of Can ml.	Density of Cheese.	Volume occupied by 12 oz. (ml.).	Headspace ml.
A	401 × 115	Springy ...	321	1·045	325	Nil.
B	401 × 201	Flat	331	1·077	316	15
C	401 × 114	Springy ...	310	1·094	311	Nil.
C	401 × 201	Flat	335	1·094	311	24

It will be noted that the two manufacturers encountering springy cans were using can sizes which allowed no headspace whatever. When manufacturer C adopted the larger size can (401 x 201) no further cases of springy cans were reported.

REFERENCES.

(1) Adam and Stanworth, "Vacuum and its Measurement," Annual Report Campden Research Station, 1932-33, 61-70.

(2) Adam and Stanworth, "The Measurement of the Internal Capacity of Cans," Annual Report Campden Research Station, 1936-37, 57-67.

THE BACTERIOLOGICAL GRADING OF EGG PULP.

By J. M. Gillespie.

The bacterial content of Australian egg pulp has been found to vary very widely from a few thousand to many millions per ml. (approx. 1/30 ounce). This variation is due to great differences in the quality of eggs from which the pulp is prepared and to subsequent conditions of handling the pulp. Egg pulp is also very liable to be contaminated by bacteria during its manufacture, and unless the extent of this can be easily and rapidly determined a product of poor quality may be produced. Although the bacterial content of egg pulp can be satisfactorily estimated by means of the plate count, the characteristics of the organisms found in egg pulp are such that it usually required three days before the results are available.

Two years ago experiments were begun in this laboratory to develop a more rapid method for judging the bacterial quality of egg pulp. The test developed, known as the resazurin reductase test, has been performed on over 300 samples of egg pulp produced in several States and found to be reliable. The equipment and degree of skill required are much less than those required for the plate count estimation and the results are available within a few hours. All types of pulp, both fresh and frozen, can be satisfactorily examined. For the interest of those engaged in the handling of egg pulp, an outline of the method is given below.

Method of Testing.

Samples of the pulp to be tested are thoroughly mixed and duplicate samples poured into test tubes (6 inch x ⅝ inch), with a mark engraved at 10ml. Then 2ml. of a standard solution of resazurin is added to each tube. The brand of this dyestuff is important, and it is recommended that the Eastman-Kodak material be used. The tubes, fitted with rubber stoppers, are repeatedly inverted to mix the contents thoroughly and then placed in a water bath thermoregulated at 86° F. The tubes are examined at thirty-minute intervals. When the blue dyestuff is first added to the egg pulp the mixture assumes a greenish hue; as reduction of the dyestuff by the bacteria proceeds the colour changes through mauve to a bright pink. Reduction is recorded when duplicate tubes show a bright pink colour. The greater the number of bacteria contained in the pulp, the faster is the rate of change of the colour of the dye-stuff.

All glassware and stoppers need to be "sterilized" by boiling prior to use.

Discussion.

In table 1 are presented some figures typical of the relation between reduction time and bacterial content of the pulp.

TABLE I.

The Relation Between Bacterial Numbers and Reduction Time.

Reduction Time (hours).	Bacterial numbers per ml.
1	40,000,000
2	20,000,000
3	10,000,000
4	4,000,000
5	2,000,000
6	1,000,000
7	500,000
8	200,000

To avoid the inconvenience of observing for a period of eight hours samples collected in the later part of the day, it is suggested that samples collected during one day be held at 32° F. overnight and the tests commenced early the next morning. Holding samples in a mixture of ice and water will ensure the maintenance of this temperature, and the change in bacterial numbers following such overnight holding will be small.

As at present conducted the resazurin test is reliable for distinguishing within a few hours between inferior and good quality samples, and therefore should be useful in helping to improve the general quality of egg pulp. In centres where egg pulp is produced the test provides a convenient check on the contamination which egg pulp might acquire from equipment such as pipe lines and pumps. Whilst pulp of low bacterial count (around 5,000 organisms per ml.) can readily be produced from fresh first-quality eggs, the bacterial content of pulp is frequently high when prepared from eggs which have been stored. The test should prove useful in detecting this form of contamination.

An inferior or third-grade product should reduce the dye in 3 hours or less, whilst pulp samples of first quality will not change colour in 8 hours. Samples intermediate in quality will reduce the colour in from 3½ to 8 hours. The reductase test could therefore be used for defining two or three quality grades in Australian egg pulp.

Readers who desire to make use of this test can obtain full details of the method and of the equipment needed by writing to this Division.

WHITE AND PINTO BEAN VARIETIES FOR CANNING.

By J. F. Kefford.

Three dry bean varieties grown in the Guyra district and forwarded by the Commonwealth Department of Commerce and Agriculture have been tested for canning quality.

Californian Small White and Little Navy are small white beans; Pinto beans are moderately large flat beans with a mottled skin.

Packs of Baked Beans in Tomato Sauce and Meat and Beans (United States Army Field Ration C) were put up in the Canning Laboratory with each of the varieties, and in addition a pack of Pinto Beans in Brine.

Californian Small White and Little Navy were both satisfactory canning varieties and showed no significant differences. Both gave small plump beans, having good flavour and a smooth tender texture, and were palatable and attractive in both of the test packs.

Pinto beans after processing were large plump beans, pinky brown in colour. Their flavour was good, having more character than the white varieties, but their texture was rather floury. While they gave quite an acceptable baked bean pack, they appear to be more suitable for use in compounded packs such as Meat and Beans, Succotash, Chili con Carne, M. and V., etc. The pack of Pinto Beans in Brine was also very palatable and attractive.

NOTES.

The following is an extract from an address recently given to Australian canners by Dr. L. V. Burton, the editor of the well-known American technical periodical, "Food Industries":—

"Probably no single question has been asked more frequently of me in Australia than what do I think of the future of the greatly enlarged canning industry here? What is to become of all the new factories? Where will the industry find a market for its products after the war-time demands dry up? Will the people of Australia transfer their affections from raw unprocessed vegetables to canned vegetables? What quality grade will the Australian housewife demand if she is to be expected to buy the products of your industry? How can the Australian housewife be educated to buy canned foods other than the old standbys that she has always purchased before the war?

The foregoing are only a few of the questions that have come up. I could think of a great many more and I am sure that each man here could increase my list by manyfold if he would begin to think of the post-war problems he must solve. It seems to me, however, that all the questions are the same questions that each canner must solve. The same questions will apply to every firm in the industry, and for the life of me, I cannot see why one set of answers would not be as good as fifty, provided they are properly obtained with thoroughness and accuracy. This it would seem to me would be a job for the trade association to study.

Not long ago I suggested to one canner that the industry ought to make a market survey of the post-war future and work out a carefully considered report on the relationship of the manufacturing capacity to the predictable market. It would seem to me that this is the most logical method of preparing for the problems of the post-war period. I feel reasonably certain that such a report if prepared by competent personnel would some day be of great value in presenting it to your Government with a carefully-reasoned recommendation from the entire industry to the Government as to what the industry wants the Government to do about it. In my short stay in this country I am unable to learn whether the initiative comes from industry or from Government. But if my past experience in my own country is of any value to you, it would be my recommendation that industry take the initiative.

I have spent several Sundays on the Domain in Sydney trying to form an estimate of the situation, and of one thing I am already convinced. There are certain groups in Australia that have a program, groups that know what they want in the future. It would be folly for industry to fail to have a constructive program of its own. One of the political axioms is that you cannot defeat *something* with *nothing*. A post-war program of the canning industry is an urgent need, and it cannot be effectively formulated unless you have an organisation of your entire industry."

Owing to the late appearance of Vol. 4, No. 1, of this Quarterly, it has been decided to group Nos. 2 and 3 together in this issue.

Sydney: Alfred Henry Pettifer, Acting Government Printer.—1944.