FOOD PRESERVATION QUARTERLY

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Editor :
W. A. EMPEY

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COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH
ORGANIZATION, HOMEBUSH, NEW SOUTH WALES, AUSTRALIA

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Commonwealth Scientific and Industrial Research Organization

For the first time we go to press under our new name—Commonwealth Scientific and Industrial Research Organization. The change from Council for Scientific and Industrial Research is the result of an Act recently passed by the Commonwealth Parliament. The Act, which was proclaimed late in May 1949, has not only given us a new title; it has also altered the constitution of C.S.I.R. The new organization, C.S.I.R.O., will be controlled by an Executive of five, with which will be associated a larger Advisory Council. Formerly the Council was, legally, the governing body; and the Executive Committee carried on its business between meetings. The Chairman of the new Executive is Dr. I. Clunies Ross and the Chief Executive Officer Dr. F. W. G. White, both of whom were on the previous Executive. Dr. S. H. Bastow is the third full-time scientific member. There are also two part-time appointees, Messrs. D. A. Mountjoy and H. J. Goodes.

The C.S.I.R. Chairman, Sir David Rivett, was not available to serve on the new Executive. Sir David was the first Chief Executive Officer of C.S.I.R., and held the position from 1926-45. On January 1, 1946, he succeeded the late Sir George Julius as Chairman and continued in office till his retirement in 1949. Sir David's outstanding ability as a scientist and administrator and his likeable human qualities attracted many to work in C.S.I.R., and helped to give it a world reputation. It is pleasing to record that Sir David will not completely sever his connection with C.S.I.R.O., having accepted the position of Chairman of its Advisory Council. Sir David has recently been elected to the position of General President of the Society of Chemical Industry, a professional body with branches throughout the British Commonwealth and in U.S.A. The Division of Food Preservation and Transport warmly congratulates him on being chosen for this high office.

C.S.I.R.O. will also be without its former Chief Executive Officer, Dr. A. E. V. Richardson, who did not seek appointment to the new organization on account of ill health. Dr. Richardson, like Sir David Rivett, has had a long association with C.S.I.R. He became part-time member of the Executive in 1927, when he was Director of the Waite Agricultural Research Institute of the University of Adelaide. In 1938 he became a full-time member of the Executive, and when Sir David Rivett retired from the position of Chief Executive Officer on December 31, 1945, Dr. Richardson assumed that office. Dr. Richardson has made notable contributions to agricultural science in Australia, and was President of the Australian and New Zealand Association for the Advancement of Science at its Perth meeting in 1947. The Division of Food Preservation and Transport trusts that freedom from official duties will benefit Dr. Richardson's health, and that his period of retirement will be a long and happy one.

Studies of Packaging Materials and Packages For Frozen Foods*

By

G. Kaess

Packages for foodstuffs which are to be held in the frozen condition for periods up to one year should preferably possess the following properties :

(1) Low permeability to air, water-vapour and other volatile substances.
(2) They should not impart or transmit undesirable odours or flavours to the products.
(3) They should show a high degree of resistance to the action of substances such as water, food juices, fruit acids and fats.
(4) Their mechanical strength should be sufficient to withstand the stresses of the usual handling.
(5) They must be capable of being effectively sealed by a simple method such as heat.
(6) Their desirable properties should not be impaired at low temperatures.

An accurate knowledge of the properties of packaging materials is necessary in order to design packages for frozen foods. The following information is taken from publications (Kaess 1943, 1944) containing the results of the author's investigations of the properties of a large number of packaging materials.

(1) Permeability to Water Vapour

Loss of water beyond a certain level results in undesirable changes in the appearance of the surface of the frozen products ; in extreme cases of drying there may also be some deterioration in flavour. The author's experimental studies were carried out along the following lines :

(*a*) Measurement by a laboratory method of the water-vapour permeability of the packaging material.
(*b*) Determination of the limiting weight losses above which deterioration in quality became apparent.
(*c*) Measurement of the water-vapour permeability of complete packages under usual commercial conditions.
(*d*) Establishment of a relationship between (*a*) and (*c*).

Laboratory Measurements of Water-vapour Permeability

The water-vapour permeability of more than 150 samples of packaging materials was determined at 5° F. and 68° F. by the method of Wolodkewitsch (1940). Moving air (6 ft. per second) was used and a relative humidity range of from 70% to 100% at 5° F. and 65% to 100% at 68° F. was studied. Measurements were made with two sets of conditions

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* The results described in this article were obtained by the author while a member of the staff of the Institut für Lebensmittelforschung, Munich, Germany.

on the high humidity side, namely, direct contact with liquid water or ice, and contact with air of high relative humidity. The measured values, expressed in mg. per dm.^{2} per day, for the specified relative humidity differences were 10 to 80 times greater at 68° F. than at 5° F. In air moving at 6 ft. per second the permeabilities were 1·3 to 3 times as great as in still air. The effect of contact with water was different for different materials, for instance, with a sample of Viscose (lacquered) film, the transmission with one side in contact with water was roughly twice as great as when the high humidity side was in contact with humid air; under similar conditions waxed parchments showed a 3- to 16-fold difference, whereas, with a polyvinyl-chloride film the differences were negligible. The effects with Viscose film may be explained by the Von Schroeder effect as described by Freundlich (1922). The effect with wax paper is probably due to capillary absorption by fibres incompletely covered with wax. Sharp folding of lacquered Viscose film, and of laminated metal foils and of papers impregnated with mixtures of wax with plastics, resulted in 30% increase in the average permeability.

Low values of the water-vapour permeability at 5° F. (0 to 10 mg./dm.^{2}/day) were found with moisture-proof Cellophane, lacquered glassine, a packaging material laminated with mixtures of wax and plastics, Pliofilm, polyvinyl-chloride film, metal foil laminated with paper, cardboard or plastic film.

Weight Losses and Quality Changes in Packaged Frozen Food

Desiccation effects generally appear first in the outer layers, and particularly at edges. Temperature fluctuations can lead to evaporation from the product and precipitation on the walls of the package.

With a series of ordinary commercial packages (800 cm.^{3}) filled with different fruits and vegetables without the addition of liquid and stored at 0° F.—80% relative humidity the weight losses in a year were 1 to 1·5%, and there was no change in appearance due to this level of desiccation. Above this level, however, deterioration became clearly visible. Beans, spinach, peas and raspberries are particularly sensitive to desiccation; when packed in syrup desiccation effects are negligible. For storage of frozen fish the weight losses should not exceed 0·8% per year, otherwise freezer-burn will occur.

Water-vapour Permeability under Practical Storage Conditions

For the design of packages it is necessary to know the various diffusion resistances for the complete package. The following types of packages filled with wetted paper pulp instead of frozen food were studied at 5° F. and 75% relative humidity:

Retail packages made of plain and impregnated cardboard with and without moisture-proof wrappers or bags made from different packaging materials, and also master cartons with and without retail packings.

For the analysis of the results, a water transfer coefficient, analogous to a heat transfer coefficient was used. This is defined as the rate of transfer per unit area per unit water vapour concentration difference between the two sides. Estimates of the overall transfer coefficients for composite structures can be obtained by compounding the coefficients for the individual components by the methods used for calculating overall heat transfer coefficients for composite structures.

The following values were obtained by measurement:

	Water-vapour Transfer Coefficient
Free water surface	$66 \cdot 3 \times 10^{-3}$ cm./sec.
Folding cardboard box (uncoated) ..	30×10^{-3} ,,
Cellophane AST	$2 \cdot 26 \times 10^{-3}$,,

49 other values are given in the original publications (Kaess, 1943).

For a master package holding 32 retail packages each 800 cm.^{3} a weight loss of 1% per year corresponds to a water-vapour coefficient of $2 \cdot 03 \times 10^{-3}$ cm./sec.

This value could be obtained with a single barrier, e.g., of Cellophane AST, or alternatively part of the resistance might be in the outer carton with added resistance provided by an inner bag or bags. It was found experimentally using a corrugated fibre-board master carton to hold 32 retail packs, that better results were obtained using a large moisture-proof cellophane bag enclosing all the small packages (water-vapour transfer coefficient$=0 \cdot 95 \times 10^{-3}$) than using cellophane wraps for the individual units (water-vapour transfer coefficient$=1 \cdot 9 \times 10^{-3}$).

Relation between Water-vapour Permeability Measured in the Laboratory and under Commercial Storage Conditions

As already stated, the weight losses of the stored foods should not exceed 1 to 1·5% per year if deterioration is to be prevented. For a master carton of corrugated fibre-board containing 32 retail packs (800 cm.^{3}), the water-vapour transfer coefficient must not exceed $2 \cdot 03 \times 10^{-3}$ to $3 \cdot 05 \times 10^{-3}$ cm./sec. The resistance can be provided by a single barrier having a permeability at 5° F. not exceeding 12 mg./dm.^{2}/day measured with an air speed of 6 ft. per second and humidity difference of 30% (100% to 70%). For liquid packs, measurements should be made with water or ice in contact with the high humidity side of the material being tested.

(2) Permeability to Air

In the presence of atmospheric oxygen oxidative changes in foodstuffs can bring about deterioration in colour, flavour and vitamin content. It is desirable, therefore, to exclude oxygen from frozen food packages as far as possible.

Most of the packing materials used for frozen foods are highly impermeable to air. With the usual apparatus accurate measurements of the permeability to air cannot be obtained. With the apparatus of Wolodkewitsch (1943), it was possible to make measurements with the common types of cellophane, lacquered glassine, waxed papers, and laminated metal foils, etc.

Most of the packaging materials tested showed values of 0–1 cm.^{3}/dm.^{2}/day, except cardboard and some papers which are not commonly used for frozen packs. Folding, scribing and the like, and also crystallization in waxed papers, can increase these values. The permeability to air of complete packages was measured by the author's method and gave values of 1 to 7 litres per hour with an inside pressure of 15 cm. of water. The permissible limit of this value is not known.

It has been shown that with some of the particularly sensitive fruits, e.g. strawberries, substantial improvement in quality retention was obtained by reduction of the oxygen concentration to very low levels by added nitrogen (Kiermeier and Kaess, in press).

(3) Permeability to Volatiles

The package must restrict exchange of volatiles with the storage atmosphere. Some frozen goods have a distinct natural odour, e.g. raspberries, strawberries, tomato pulp, onions, fish.

Permeabilities to volatiles were measured with a piece of apparatus consisting of two chambers. One contained the volatile test material and was separated from the other by the packing material being examined. After a definite time the concentration of volatiles in the second chamber was determined subjectively using an odour-scoring scale with 6 points. Aluminium foil alone or laminated with paper or plastic films, and polyvinyl chloride films were completely impermeable to volatiles. Lacquered glassine and a double waxed paper showed high resistance. Lacquered glassine and Cellophane AST were generally sufficiently resistant to volatile transfer for packing frozen goods. In special cases, particularly with frozen onions, packing materials more resistant to volatile transfer are needed, e.g. metal foils.

(4) Interaction of the Package and Foofstuff

A paper which will stand a water pressure of 16 cm. for six hours without breakdown can be considered sufficiently resistant to *liquid* water. Liquid from a pack of spinach will penetrate packing materials more readily than pure water. Metal foils are sensitive to fruit acids and should have good surface coatings to protect them. Unpublished observations have shown that liquid packs of low pH (2 to 3) increase the water-vapour permeability of lacquered materials and also of paper laminated with a wax-plastic mixture. A similar effect was observed when packing materials were immersed in water for a long time. Fruit juices can dissolve the plasticizer in packing materials, so increasing the tensile strength, but decreasing the elongation. It seems that cartons containing 60% mechanical paper pulp give less off-flavour to frozen apple juice than pure cellulose cartons.

The package must give no off-flavour or off-odour to the goods. On opening, the package should have a smell typical of the goods in it.

(5) Mechanical Requirements

For efficient heat transfer during freezing, the packing material should be as thin as possible, consistent with adequate strength. The packages must be sufficiently resistant to the effects of condensed water on the outside and liquid on the inside during thawing. For retail packs adequate resistance may be specified as at least 140 gm. " wet stiffness ", as measured with Bekk's apparatus.

(6) Materials Suitable for Frozen Packs

Among the materials which have a sufficient resistance to water-vapour transfer to be used as wrappers or bags and laminates are :

Cellophane MSAT, lacquered glassine, special papers impregnated with wax-plastic mixtures, Pliofilm FF, Polythene, polyvinyl chloride film, some polyvinyl copolymers, polyvinylidene chloride-films and copolymers, styrol-isobutylene copolymer film, and laminated metal foils.

Cartons used in conjunction with any of the above would need to be resistant to liquid water, but would not require resistance to water-vapour. If a carton is used without supplementary water-vapour barriers inside, it would need to be proof against water-vapour. This proofing could be by means of wax-plastic mixtures, plastic impregnation or by lamination with metal foils or plastic films.

Summary

The package has an important part to play in the maintenance of good quality in frozen foods. The characteristics necessary for the protection of the food are discussed. The most important of these are permeability to water-vapour, air and volatile substances. A limiting value for water-vapour permeability is given, together with data for some specific cases. Limits for permeability to air and volatiles cannot be specified, but it is recommended that these be kept as small as possible. Other requirements of frozen food packages are discussed.

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HANDBOOK OF AUSTRALIAN SCIENTIFIC AND TECHNICAL SOCIETIES AND INSTITUTIONS

The Information Service of the C.S.I.R.O. is proposing to compile a handbook of Australian research institutions and scientific and technical societies, somewhat on the lines of the wartime publication " Science on Service ", which some readers may remember. The handbook will be made available to the scientific public, and will include brief details of the history, location, organization of activities, membership, publications, etc., of each institution listed. The information will probably be collected largely by means of questionnaires.

The Information Service has already compiled a fairly complete list of such organizations, which will be used as a mailing list for the questionnaires. As a check, however, it is suggested that secretaries of societies or institutions which would like to be included in the list should write to the Officer-in-Charge, C.S.I.R.O. Information Service, 314 Albert Street, Melbourne, C.2, for a copy of the questionnaire.

A further announcement will be made in the FOOD PRESERVATION QUARTERLY when the handbook is published.

Pasteurization of Liquid Eggs

By
W. J. Scott

At the time of manufacture liquid egg contains considerable numbers of bacteria, and numbers in excess of one million per ml. are not at all uncommon in products prepared in this country (Scott and Gillespie, 1944) or overseas. These bacteria are derived mainly from the shells of the eggs and from contaminated equipment in the egg breaking establishments. When the liquid egg is prepared from sound fresh eggs the egg contents will generally be free from infection, but with pulp made from cracked or stored eggs a considerable part of the contamination may be due to organisms which have grown within the egg.

The presence of large numbers of bacteria in liquid egg is undesirable as such products have a very poor keeping quality, and the risks of incipient spoilage due to further growth during slow freezing or thawing are considerable. Most of the bacteria are not dangerous to the public health, but from time to time disease-producing bacteria are present in liquid eggs. The most important of these are the Salmonella types, which are the cause of enteric diseases in man and other animals. Organisms of this type may produce disease in man when only very small numbers are ingested, and it is important, therefore, that they should be absent in foods intended for human consumption. Salmonella organisms have been detected in approximately one-third of a large number of batches of dried egg which were produced in North America (Gibbons and Moore, 1944; Solowey and others, 1947) and strong evidence has been produced that some of the powders so contaminated were the cause of outbreaks of food poisoning in the United Kingdom (Great Britain Med. Res. Coun., 1947). Such outbreaks are likely to occur when the contaminated egg product is incorporated in a dish which is subjected to only light cooking and in which the pathogenic bacteria may survive. The risks may not be high, but are nevertheless real.

How then may it be ensured that liquid egg products are always free from such pathogenic organisms? Workers in North America have shown that the organisms almost always reach the liquid egg from contamination on the shells (Sollowey and others, 1947), but in two instances, at least, it has been clearly demonstrated that the contents of hen eggs contained Salmonella organisms which were the cause of food-poisoning in man (Watt, 1945; Crowe, 1946). In these circumstances, it is clear that it would be difficult, if not impossible, to guarantee that liquid eggs could always be prepared free from such pathogenic bacteria. The possibility of destroying Salmonella organisms by pasteurizing the liquid eggs has been studied and found to be practicable.

Pasteurization may be carried out by either of two methods. The first is the batch or holding method in which quantities of liquid egg contained in a suitable vat are heated to the pasteurizing temperature and maintained there for a specified period of the order of 20 to 30 minutes. The second method is carried out by rapidly heating and cooling the pulp in a suitable heat exchanger, the period at the maximum temperature usually ranging from a few seconds to about one minute. Both methods will give satisfactory destruction of bacteria without causing coagulation or significant loss of quality for baking purposes.

For vat pasteurization holding at 140° F. for 30 minutes has been found sufficient to destroy all coliform bacteria, Salmonellas, Staphylococci and group A Streptococci (Gibbons and others, 1946). The process was generally able to destroy more than 99·9 per cent. of the bacteria initially present. Holding at temperatures around 135° F. may be sufficient to destroy more than 99 per cent. of total bacteria within 30 minutes, but is much less effective in destroying coliform bacteria.

For flash-pasteurization temperatures up to 146° or 148° F. may be used for about 20 seconds without causing coagulation. The maximum possible pulp temperatures will be partly dependent on the type of heat exchange apparatus, somewhat higher egg temperatures being permissible in efficient exchangers operating with a small temperature differential between the liquid egg and the water used for heating. Experiments in laboratory-scale apparatus have shown that such time-temperature combinations as 30 seconds at 146° F., 60 seconds at 144° F., and 90 seconds at 142° F. were adequate to destroy virtually all the coliform and Salmonella organisms occurring in egg pulp (Winter and others, 1946—two references). They were also sufficient to destroy more than 99 per cent. of all bacteria present. A larger scale trial carried out in these laboratories with a commercial plate-type heat exchanger showed a 99·5 per cent. reduction in bacterial numbers when the liquid egg was raised to 142° F. for 30 seconds. There was no coagulation of egg on the plates, the water temperature being maintained at 147½° F. This test showed that prior homogenization of the pulp would be useful as the reduction in viscosity would result in still better heat transfer between the egg and the heating surfaces.

When liquid egg has been pasteurized prior to spray drying, it has been found that the preheating has increased the capacity of the drier and facilitated the production of powders of low water content. When the pasteurized egg is to be frozen, rapid cooling is important. Where flash-pasteurization is carried out in plate-type heat exchangers it becomes a comparatively simple matter to cool rapidly with the same equipment supplemented with additional plates for water and/or brine cooling. Rapid cooling to around 35° F. will virtually eliminate the possibility of bacterial growth between pasteurizing and freezing and would contribute to somewhat more rapid freezing.

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Notes on The Processing and Storage of Salami Sausage

By

W. A. Empey

Introduction

In the book " Sausage and Ready-to-Serve Meats ", prepared by the Institute of American Meat Packers and published by the University of Chicago, Illinois, in 1938, Salami is mentioned as a " dry " sausage which probably originated in the city of Salamis, located on the east coast of Cyprus and destroyed about 449 B.C. Dry sausage as it is known today, however, is primarily of European origin, with the largest number of present-day products traceable to Italy. Ancient peoples had no means of artificial refrigeration and were dependent mainly on the use of salt and sun-drying or smoke-drying as a means of preservation of meat. With the advent of mechanical refrigeration in the nineteenth century it became possible to apply methods of control during processing which resulted in the production of meat products of better quality and at the same time greatly reduced the risks of spoilage during their manufacture. Complete details of such up-to-date methods as applied in the U.S.A. to the manufacture of dry sausage, including Salami, are given in the book previously mentioned. In this article it is intended to discuss the subject of microbial spoilage and to consider the means whereby the risks of such spoilage can be reduced to a minimum.

Spoilage

Because Salami is prepared from raw meats and is then held for long periods of drying and maturation, usually without having been previously cooked or exposed to high temperatures, it should be regarded as a highly perishable product subject to microbial spoilage which may in some cases result in a danger to the health of the consumer. Spoilage of Salami by bacteria and/or moulds is possible at any stage during its preparation and storage before the moisture content is reduced to a sufficiently low level, or until the product is stored at a temperature at which microbial growth is not possible. It is customary to include a certain proportion of salt together with small amounts of saltpetre and spices in the formulae used for making Salami. These substances, particularly the salt, provide some protection to the product against microbial spoilage, but in order to ensure a sufficiently long life at ordinary air temperature it is necessary to remove a considerable proportion of the water from the product. If it is intended to store the material in the frozen condition it is not necessary, from the aspect of protection against micro-organisms, to remove water, but the product would not then possess the true Salami characteristics which are supposedly developed during a long period of drying and maturation.

Selection of Materials

The meats used for preparing Salami should be in perfectly sound condition and kept refrigerated during the preliminary processing until the mixture of salt and spices has penetrated them. The proportion of pork and beef used vary somewhat according to published formulae, but it has been stated that too much fat will seriously affect the binding quality of the sausage.

The proportion of added salt ranges between $2\frac{1}{2}$ and $3\frac{1}{2}$ lb. per 100 lb. of mixed meats. The addition of too high a percentage of salt is said to render the product less palatable.

Processing

It is important to avoid undue rise in temperature of the material during the operations of trimming, chopping, mixing, curing and filling into casings. During these operations the temperature should be kept below 50° F., and it is customary to maintain temperatures of 36° F. to 38° F. in the curing process which may extend over two or three days with some types of sausage.

Drying

It is not possible to state the exact water content at which microbial growth is not possible in the product since this will be influenced to a great extent by the percentage of added salt. The moisture level at which most bacteria are incapable of growth will, however, be considerably higher than in the case of moulds. From the practical aspect the greatest danger of spoilage will be during the initial stages of drying, particularly in the deeper layers of the sausage, where the rate of water removal may be slower than at the surface. The risks of spoilage by the very dangerous botulinus bacteria can be avoided by not allowing the product to rise in temperature beyond 55° F. while the moisture content remains high enough to permit their growth. The activity of other harmful types of bacteria such as the toxin-producing Staphylococci which may cause food poisoning will also be reduced by drying at low temperatures. It is probably for this reason that the recommended temperatures for drying and maturation of Salami are from 52° F. to 56° F. The temperature range of 90° F. to 110° F. can be regarded as being favourable to the growth of dangerous bacteria and for this reason it would be safer to make use of higher temperatures (e.g. 130° F. to 140° F.) if a quick drying process is to be employed. At the latter temperatures the only microorganisms capable of active growth are thermophilic bacteria. If the temperature of the *sausage* is held within this range for a sufficiently long period, e.g. two to three hours, an appreciable pasteurization will be obtained. A similar effect could be obtained by an appropriate cook in hot water but, although this is commonly practised with other types of sausage, there is no record of its use in the manufacture of Salami. The essential character of the product would probably be changed by cooking, and according to " Sausage and Ready-to-Serve Meats " overheating is often responsible for poor colour, while smoking at high temperatures may destroy the desired firmness of texture.

Whatever method of removal of water is employed, it is important to dry the sausage uniformly and to avoid " case-hardening " and leaving the interior in an excessively moist condition, conducive to the growth of bacteria and moulds. Drying rooms in which the temperature, humidity and air distribution are subject to mechanical control are often used in order to ensure the best quality, colour, flavour, and general appearance of the product.

Shrinkage during Drying

The extent of shrinkage required to reduce the moisture content of the product to a safe level will be influenced by the initial moisture content of the mixed ingredients, and this will in turn be dependent to a large extent on the percentage of fat which is present. Data given in the following table include the approximate shrinkages which are necessary to protect the product of variable initial composition, from the risks of spoilage by certain harmful bacteria and by moulds. The protective effect due to the attainment of certain levels of moisture is based on the assumption that drying has been uniform throughout each individual unit of Salami. In practice it will be found extremely difficult to obtain uniformity of moisture content throughout a sausage even after long periods of holding, and very often the moisture content of the interior will be higher than at the surface.

Fat and Water* Contents of Original Mixture.		Added Salt. %	Salt and Ash. %	Shrinkage and Final Water Contents to Produce Following Concentrations (by Weight) of Salt plus Ash in Aqueous Phase.			
				Salt and Ash=12·5%.		Salt and Ash=25%.	
Fat. %	Water. %			Shrinkage. %	Water Content. %	Shrinkage. %	Water Content. %
20	62	2·5	3·5	35	38	49	22
		3·5	4·5	28	44	46	26
30	54	2·5	3·5	27	34	41	17
		3·5	4·5	20	40	38	23
40	46	2·5	3·5	19	31	33	17
		3·5	4·5	12	36	30	20

* The water content of the meat is calculated from Callow's formula: Water=77% minus 0·77 × % fat.

The selected levels (12.5% and 25%) of salt plus ash in the aqueous phase correspond roughly to those which would be required, in the first case to protect the product from the growth of bacteria such as botulinus and certain staphylococci which are dangerous to human health, and in the second case to inhibit the growth of moulds. Taking as an example an original meat mixture containing 30 per cent. fat and 3·5 per cent. added salt it will be seen that the approximate shrinkage required to obtain the safety zone for such bacteria will be 20 per cent., and for moulds 38 per cent. It is of interest to note, according to a description in "Sausage and Ready-to-Serve Meats", that dry sausage is usually sold in three different ways: first, new sausage, between 10 to 25 days after smoke (approx. 20 per cent. shrink); second, medium dry, between 30 to 60 days after smoke (approx. 32 per cent. shrink); third, dry, 60 to 90 days and over (approx. 40 per cent. shrink). As indicated in the table, the shrinkages which are required to produce a given percentage of salt plus ash in the aqueous phase increase with increasing water content in the original mixture and decrease with increase in the percentage of added salt. Considerations of the final saltiness in flavour, however, limit the amount of salt which is added.

Maintenance of Level of Moisture Content

Under ordinary storage conditions it is virtually impossible, without the aid of moisture-vapour-proof coatings, to prevent either uptake by or a loss of water from the product. In storage atmospheres of sufficiently high relative humidity the uptake of water by the product may be enough to permit the growth of microorganisms with consequent spoilage. At low humidities there may be a continued loss of water. Suitable substances which may be used in the form of coatings to prevent change in weight in the product are :

(*a*) Paraffin wax (either alone or mixed with rubber-like plastics) and micro-crystalline waxes.

(*b*) Watery emulsions of plasticized plastics which are impermeable to water-vapour.

The substances specified in (*a*) and (*b*) may be applied direct to the product.

(*c*) Rubber, used as a separate covering in intimate contact with the product, as in the Cry-O-Vac process.

These bags could be used for holding one or more sausages.

Provided that the coatings mentioned remain unbroken and impervious to air and water-vapour, the product will remain unchanged in weight. When stored at high temperatures, the fats will become rancid more rapidly than at lower temperatures, while in atmospheres of high humidities moulds may grow on the surface of the coatings, particularly if they have been soiled with meat juice or particles of meat tissues.

Storage of Low Temperatures

The storage life of the product which is susceptible to spoilage at ordinary temperatures will be prolonged by lowering of storage temperatures, but it will be necessary to reduce these below 20° F. to ensure complete freedom from microbial growth. Salami which has initially been insufficiently dried to render it free from likelihood of spoilage at ordinary temperatures, and which does not dry out to a safe moisture level during frozen storage will again become susceptible to spoilage after thawing and holding at temperatures favourable to microbial growth. It is possible for Salami to lose or gain water even in the frozen condition, depending on the relative humidity of the storage atmosphere, although the rate of change would be considerably slower than in atmospheres of similar relative humidities at temperatures above freezing point.

Paraffin wax alone would not prove suitable as a coating under frozen storage conditions, due to its tendency to become brittle and crack at low temperatures, but the other coatings specified in (*a*), (*b*) and (*c*) should prove effective.

Apple Juice Blends

By

D. J. Menzies and J. F. Kefford

An interesting recent trend in the canned fruit juice industry in America is the popularity of a number of mixed fruit juices or blends. Blended orange and grapefruit juice was among the first to be produced and now has a well-established market because it shows rather greater flavour-stability than canned orange juice. Other blends based on citrus juices include grapefruit and pineapple juice (Anon., 1949) and "Citrus cocktails" containing orange, lemon and grapefruit juice (Anon., 1947), or, in one instance (Anon., 1946), orange, lemon, grapefruit, lime and apricot juices.

Apple juice has also been used as a base for fruit juice blends (Anon., 1948; Coe, 1940; Pederson and others, 1941). One of the authors had the opportunity of sampling a very attractive blend of apple and raspberry juices at the New York State Agricultural Experiment Station in Geneva, N.Y., and of seeing in commercial production in the Okanagan Valley in British Columbia, a canned apple-lime juice blend.

During the 1948 apple season, a number of experimental packs of apple juice blends were canned at the Homebush Laboratory of this Division, using passionfruit, pineapple, grapefruit, lime, youngberry and boysenberry juices as the added ingredients.

The basic apple juice was extracted from cold-stored Granny Smith apples by milling in a grater mill, pressing the pomace in a hydraulic rack-and-cloth press, and screening through stationary screens of 12 and 20 mesh. This juice had a fresh, bright flavour and colour but was weak in apple character, having a soluble solids content of 9° Brix and an acidity 0·4% as malic acid. Pineapple juice was extracted from whole pineapples in the same equipment, and also the berry juices after freezing and thawing the fresh berry pulps. Grapefruit and passionfruit juices were extracted by hand-reaming and screening through the same screens. The lime juice was a commercial product of West Indian origin preservatized with sulphur dioxide.

From the apple juice, with the addition of the other juices at various levels, and in some cases, with the addition of sugar, the following blends were prepared:

Apple-Passionfruit	5%, **10% with 1% sugar.**
Apple-Lime	2%, 2·5%, 3%.
Apple-Grapefruit	**25% with 1% sugar.**
Apple-Pineapple	25%, 50% with 1% sugar.
Apple-Youngberry	**22% with 1% sugar,** 50% with 2% sugar.
Apple-Boysenberry	**22% with 1% sugar,** 50% with 2% sugar.

The blends were cold-filled into lacquered cans, vacuum-sealed, and pasteurized in steam for two minutes while rotating at approximately 100 r.p.m. This treatment is known to give centre temperatures of at least 195° F. Immediately after pasteurization the cans were cooled by rotation at the same speed under cold water sprays.

After storage for one month, the blended juices were submitted to a panel of about 25 members of the laboratory staff for assessment of quality.

First, triangular tasting tests (Helm, 1946) were conducted to determine which blend of each type was preferred, and the blends with preferred composition are indicated above in heavier type. Then these preferred blends, together with the Apple-Passionfruit (5%) blend, were submitted to a consumer reaction test.

All the blends were rated as superior to plain apple juice. Both the Apple-Passionfruit blends were especially attractive in flavour and were received very enthusiastically. The others were ranked in the following order: Pineapple, Lime, Youngberry, Boysenberry, Grapefruit. Most of the blends had flavours best described as characteristic of the added juice but with a background of apple flavour. In the Apple-Lime blend the apple character was completely submerged but the product was a very palatable and refreshing lime beverage. The two berry blends were very attractive in colour but it is likely that blends based on other types of berries, notably raspberries, would be more pleasing in flavour.

Apple juice blends, we consider, merit the attention of Australian manufacturers of fruit juices; particularly Apple and Passionfruit juice, which is outstanding in flavour and which this country is in a favourable position to produce.

References

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ANON. (1947).—Food Pack. 28 (No. 13): 41.
ANON. (1948).—Fruit Prod. J. 28: 21.
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YEAST FROM FOOD WASTES

In an abstract (*Food Industries*, Vol. 21, No. 2, February 1949) taken from a paper entitled "The Production of Yeast from Agricultural Wastes", by W. D. Ramage and J. H. Thompson, presented at Yeast Symposium, Milwaukee, Wisconsin, November 1948, it is stated that pilot-plant operations have indicated the practicability of producing yeast from fruit and vegetable processing wastes. Two independent continuous pilot plant operations—one using citrus-peel liquor and the other using juice from pear-waste are described. Effective aeration furnished by the mechanical air dispersing system with which the yeast propagator in the pear-waste plant is equipped, and the exact maintenance of a constant pH near the optimum point by means of instrument control, resulted in unusually large yeast output. The wort and ammonia feed was regulated by a pH controller.

Chili Sauce

By

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Chili Sauce is a product of the same general character as Tomato Sauce but differing in consistency, in the presence of tomato seeds and in its content of spices and other flavouring materials. Because of the popularity of this condiment in America, available formulations were tested and modified to produce a sauce comparable in quality with well-known brands.

Chili Sauce is made from whole tomatoes from which skins and cores but not seeds have been removed by passing the chopped fruit through a cyclone with a $\frac{3}{4}$ in. mesh screen. Fifty gallons of material so prepared is mixed with a similar quantity of peeled cored whole tomatoes, in order to give the lumpy consistency characteristic of the product. The mixture is reduced in bulk to 60 gallons in a steam-jacketted pan, and the following constituents are then added :

Sugar	80 lb.
Salt	7 lb.
Ground onions	18 lb.
Garlic powder	$1\frac{3}{4}$ lb.

Cooking is continued until the volume is reduced to 40 gallons. The steam is then turned off and a spice mixture incorporated as follows :

Vinegar ..	5 gallons	
Clove oil ..	30 parts	100 millilitres
Cinnamon oil ..	25 parts	
Allspice oil ..	30 parts	
Mace oil ..	5 parts	

The sauce is then finished by stirring continuously for five minutes, after which it is filled hot into wide-neck bottles.

Technically the end point of the cook for Chili Sauce is obscure. A refractometer reading of 1·3793 (68° F.) corresponding with 30 per cent. total solids may be taken as an approximate indication of the finishing point. Careful attention must be given to the consistency of the product in determining the stage at which cooking is terminated.

The amount of spice to be added will vary with individual preference, but an impression is current that a moderately flavoured and rather mild product would be favoured by the Australian consumer.

Answers to Inquiries

(1) COLD STORAGE OF CHILLED MEAT IN SMALL REFRIGERATING CHAMBERS

Conditions recommended to ensure the longest possible storage life of meat, without freezing, in small refrigerating chambers are as follows :

1. The meat should be as free as possible from contamination by bacteria and moulds when placed in the refrigerator. Under the usual conditions of slaughtering and dressing of carcases in a typical abattoir it is very difficult to reduce the microbial contamination of the surfaces of the meat below 500,000 organisms per square inch, but by careful handling and the adoption of hygienic precautions as applied in preparing chilled beef for export from Australia these numbers could be reduced to about 50,000 per square inch. Under good conditions of chilling at the abattoir or meatworks there should be no increase in the numbers of surface micro-organisms during a holding period of one day or longer.

The meat should be properly wrapped in clean cloth or stockinet (for protection of the surfaces) during removal from the abattoir to the refrigerator.

In order to ensure that the meat selected for storage has been handled under the best possible conditions it would be preferable to obtain supplies direct from the meatworks.

2. The meat should be as low in temperature as possible, without being frozen, when removed from the meatworks and temperature rises between removal and placing in the refrigerator should be reduced to a minimum. The ideal temperature of the meat at removal from the meatworks is 32° F., but it is doubtful whether this would be attained within 48 hours of slaughter, particularly with beef carcases, and then only in meatworks which have good chilling conditions. When prepared for local trade, carcases of beef and mutton are usually cooled overnight to an average temperature range of about 40° to 50° F. before marketing. It would be an advantage if the refrigerator were designed so that it could cope with a load of meat in this temperature range and be capable of rapidly reducing the temperature to about 30° F.

3. Condensation of water on the surfaces of the meat during removal to the refrigerator should be avoided by protecting the surface with cloth coverings and a tarpaulin, or by packing in a box with a lid.

4. The temperature of the refrigerator should be between 30° F. and 31° F.

5. The meat should be stacked on wire-mesh racks or hung without contact with adjoining pieces and should be so arranged to facilitate removal of the daily requirements without delay.

A refrigeration set-up with a fan blowing air over direct expansion coils in the cabinet would be helpful in keeping the atmosphere dry.

6. The natural or convective circulation of air in a small refrigerating room which is not equipped with a fan could be encouraged by installing a small source of heat (such as an electric lamp) which will cause the air to circulate when the machine is at a standstill and increase the running time of the machine so as to bring the drying power of the air in the

refrigerator to a reasonable value. Low relative humidities in the air are important in promoting drying of the meat surfaces, thus restricting the growth of micro-organisms.

7. As far as possible cold meat removed from the refrigerator and allowed to develop a "sweaty" condition due to condensation of moisture from the air should not be returned to the storage space. If it is required to store other foodstuffs which are to be removed from time to time each day the possibility of building a separate section for this purpose might be considered.

8. Installation of an ultra-violet steri-lamp in the storage space may prove worthwhile for extending the storage life of the meat but the soundness of the claims made for these devices cannot be guaranteed.

9. The internal surfaces of the refrigerator and the shelves should be thoroughly cleaned and treated with a weak solution of hypochlorite each time the space is emptied.

Assuming that the instructions and precautions outlined have been strictly adhered to, the actual storage life of the meat will be determined by the numbers of micro-organisms (per unit area of surface) which are capable of active growth at a temperature of about 32° F. In view of the average level of hygiene and the prevailing conditions for the cooling of meat in Australian abattoirs, it is likely that contamination would often be sufficiently high to make storage of unfrozen meat for 14 days somewhat risky.

(2) KEEPING QUALITY OF PUDDING, CAKE, PASTRY AND BISCUIT MIXES

The fat content of these mixes will be subject to development of rancidity at a rate which would be dependent on many factors including temperature, type of fat, and the presence of other ingredients. In general, it may be said, particularly if prolonged storage is contemplated, that there would be considerable advantage in using an anti-oxidant such as ethyl gallate at the rate of approximately 0·01 per cent. of the weight of fat used. The anti-oxidant from wheat germ should also be quite effective but it is not known if this material is at present available in Australia in commercial quantities.

The keeping quality of mixtures of this type is also dependent on the water content, mould growth being possible when sufficient water is available. The availability of water to micro-organisms is best given by the equilibrium humidity (EH) of the product; this being equal to the relative humidity of an atmosphere from which the food will neither gain nor lose water. As a general guide it may be stated that the EH should not be greater than about 70 per cent. where prolonged storage is contemplated, although values up to 75 per cent. may be safe in some products for periods of several weeks. Where the EH exceeds 80 per cent. the storage life will always be very short.

In some pastry mixes examined in this laboratory the EH has been about 65 per cent. and these would, therefore, be safe from the point of view of mould wastage. Some mixes based on margarine are, however, reported to have been subject to mould spoilage within three months, and this, probably, has been due to imperfect mixing. The reason for this is that the margarine itself contains a considerable quantity of water, and if this is not uniformly mixed with the other dry ingredients there will be small patches with a high EH in which moulds are readily able to begin growth. If possible, therefore, it would be desirable to use a dry fat instead of margarine, or alternately, to take special care to insure that the ingredients are uniformly mixed at a safe level of the EH.

The packaging requirements for mixes of this type will also be dependent on the expected duration of storage, and on the conditions to which the material is likely to be exposed, as well as the initial EH of the product.

Recent Publications

(1) Polarographic Current Time Curves. By H. A. McKenzie. J. Amer. Chem. Soc. 70: 3147 (1948).

(2) Review of Recent Work on Nitrogen Metabolism. By H. S. McKee. New Phytol. 48: 1-83 (1949).

The latter paper summarizes work published between 1937 and 1947 on the changes undergone in plants by compounds of nitrogen and will be of particular value to plant physiologists and biochemists. Knowledge of nitrogen metabolism in plants is important to storage investigations, since better understanding of the vital processes in plants is essential in the development of new and improved methods of storing fruits and vegetables.

BIBLIOGRAPHIES AND SUMMARIES OF INFORMATION

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

The Officer-in-Charge,
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314 Albert Street,
East Melbourne, C.2.

The bibliographies are, in the majority of cases, selective only. Applicants should state clearly the reason the bibliography is requested, because the number of copies available is limited.

No.	Title.	Date.	No. of Refs.
B363	The pH of Egg Albumen.	July, 1948.	9
B371	Cake Mixes.	November, 1948.	7