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DRIED VEGETABLES.

Part 1.

What are the properties of satisfactory dried vegetables?

How can satisfactory dried vegetables be prepared?

The following account is intended only as an outline of the processes necessary for the production of dried vegetables of good quality. Fuller details can be obtained on application to C.S.I.R. Division of Food Preservation.

Dried vegetables should absorb water readily and return to practically their original size, form, and appearance. They should cook rapidly, with or without prior soaking, and the cooked product should be tender but not mushy. The vegetables should retain a considerable proportion of their original odour and flavour and a high proportion of their original vitamin and mineral content. They should be dried to a very low moisture content so that they will not undergo serious deterioration in flavour, appearance, or vitamin content during storage.

Fresh vegetables of good quality should be used for dehydration. Except in unusual circumstances only those varieties which have a good flavour and cook well should be used. The vegetables should be grown under good conditions and harvested at proper maturity. They should not have to be carried long distances to the drying plant and should be processed very soon after harvesting.

The first stages in processing are washing, trimming, peeling where necessary, and slicing. Washing and trimming should be carried out carefully. The equipment needed and the order in which the processes are carried out will vary according to the type of vegetable. The slicing of the prepared material requires careful attention. The slices must be thin enough to dry rapidly but not so thin that they will be difficult to spread on the drying trays. The thickness of the slices varies from $\frac{1}{8}$" to $\frac{1}{4}$" for different types of root vegetables and from $\frac{1}{4}$" to $\frac{1}{2}$" width for leafy vegetables.

The next stage in the processing is known as blanching. This consists of a short treatment with steam or boiling water. It is essential for all vegetables except onions, leeks, and sweet peppers. Blanching may also be omitted in the case of vegetables such as celery when they are to be powdered and used only as flavourings. If blanching is omitted or not carried out properly, the dried vegetables are likely to be discoloured, tough, and tasteless, and there will be a serious loss of vitamins either during drying or during normal storage afterwards. In the case of certain vegetables, of which cabbage is an outstanding example, it is necessary to add a carefully regulated quantity of sodium sulphite to the blanching liquor.

After blanching, the vegetables are spread on trays for drying. They should be spread as evenly as possible and the loading on the trays should be 1-1½ lb. per sq. foot according to the type of vegetable to be dried. The vegetables should be put into the drier as soon as possible after blanching. The temperature of the air used for drying must be carefully regulated, and varies from 140° to 160°F. according to the type of vegetable. The conditions of drying are regulated so that the time required is as short as possible and in no case longer than about 8 hours.

When dried to the moisture content required, the vegetables are crisp and brittle and can be powdered readily. They should be stripped from the trays immediately after removal from the drier and placed in air-tight bins or packed into air-tight containers for transport. Dried vegetables of low moisture content absorb water very readily from the air under normal atmospheric conditions and have to be handled and packed quickly and carefully.

To determine whether the dried vegetables reach the standards set out in the first paragraph, the following tests can be done:- the moisture and vitamin contents can be estimated; the weight of water absorbed in a given time under standard conditions can be determined; and cooking and tasting tests can be carried out.

THE USE OF AIR FOR DRYING VEGETABLES.

The drying of vegetables for preservation involves the removal of large quantities of water. Fresh potatoes contain at least 75 per cent. by weight of water, and leafy vegetables may contain nearly 95 per cent. If the dried product is to have a useful storage life, nearly all this water must be removed.

The removal of water is not in itself a difficult problem, but while the water is being removed it is necessary to make sure that the vegetables retain good palatability and nutritive value. This requirement places important restrictions on the method of water removal. On the other hand, the method chosen must be suitable for rapid production at reasonable costs. Of the available methods, the removal of water in the form of water vapour by means of hot air is the most useful for general production. This method, in conjunction with other adequate processing operations, can be controlled to give a good quality dried product which on cooking closely resembles the cooked fresh vegetable.

Function of Drying Air.

Air has two important functions in the removal of water. The first is to carry heat to the liquid water in the vegetables to change it to water vapour. The change of state from liquid to vapour requires relatively large quantities of heat, much more than is required to heat the water. The first function of the air implies that the air is cooled as it does useful work. The second function is to carry away the water vapour. It is obvious that both these purposes are best served by forcing the air to move more quickly than is possible under natural convection. The essential equipment is a heater to heat the air to the correct temperature, and a fan to move the required amount of air over the wet material.

Operating Conditions.

Although very hot dry air is efficient as a drying agent, most vegetables deteriorate rapidly if exposed to temperatures above 150°F. to 160°F. Hotter air may be used on very wet material owing to the rapid cooling effect due to evaporation of water, but the time of exposure must be short. When the air in a drier does useful work, it becomes cooler and more nearly saturated with water. Drying therefore does not take place under constant conditions throughout the drier, and it becomes necessary to decide at what point the air has been used most efficiently. It has been found that satisfactory drying conditions are possible with air at temperatures above 120°F. provided that the water content is not too high.

A wet bulb thermometer is very useful as an indicator for the operation of a drier. If the sensitive element of a thermometer is covered by a suitable bandage which is moistened and exposed to the air stream, the temperature reading will nearly always be lower than the corresponding dry bulb reading. The difference between the dry bulb and wet bulb readings (the wet bulb depression) is an indication of the drying power of the air. The two readings are the same when the air is saturated with water vapour, but dry air gives a large wet bulb depression. When the wet and dry bulb readings are known, the percentage saturation of the air may be found from appropriate humidity tables.

While air is being cooled by evaporation without the supply of heat from outside, its wet bulb temperature remains constant. When the dry bulb temperature of the air has fallen to the wet bulb temperature, the air is saturated with water vapour at that temperature. Good use may be made of the fact that air which is saturated at a low temperature is not saturated when the temperature is raised. In other words, air may be made to do more useful work by reheating it and recirculating it over the wet material.

Data for air and water vapour mixtures are available in the form of tables or graphs from which may be found the quantity of air required to supply the heat for evaporation and to carry off the water vapour so formed. The usual working range is from 120° to 155°F. which allows a temperature drop of 35°F. for heat transfer. If 1000 lb. of air is circulated, it can supply sufficient heat to evaporate about one pound of water for every 4°F. drop in temperature. After the air is cooled to 120°F., it may be reheated and used again. Part of the air should be discharged from the drier before saturation is reached so that excess moisture is carried off and the condensation of water on the cooler parts is prevented. For instance, when the dry bulb temperature is between

155° and 120°F., it is desirable to adjust the air discharge, or ventilation, so that the wet bulb temperature is kept below 110°F.

In some driers, higher efficiency is obtained by heating the air at more than one point. By this means the average working temperature throughout the drier is raised at the cost of some complication in controls and equipment. Arrangements are possible which give drying conditions most suitable for the various stages throughout the drying process.

When the air temperature drops from 155° to 120°F., one ton of water can be evaporated in 24 hours by providing an air flow of 3,000 cubic feet per minute. The fraction of air which is discharged will depend on the temperature and percentage saturation of the discharged air. It should be noted that the rate of evaporation given above does not indicate the output of dried vegetables. The output depends on the rate of water removal in relation to the weight of vegetables in the drier, and it is determined by several factors some of which are discussed below.

Rate of Water Removal.

There are two main factors which control the rate at which water is removed, or the rate of production of dried vegetables. The first factor is the condition of the drying air, and the second is the way in which the vegetables are prepared for drying. The following facts must be kept in mind when considering the design and operation of an efficient drier.

It was stated above that the maximum air temperature allowable is about 155°F., although wet material may be exposed to air of higher temperature for a very short time. For rapid drying the air should be kept as near this maxium temperature as can be controlled. Heat is conserved by discharging air of high water content from the coldest part of the drier, but this saving is limited by the fact that drying is very slow when the air is cooled by approaching saturation.

The final stages of drying need special attention. The removal of water from the nearly dry vegetables is much slower than from the wet material, and drier air is required to complete this stage of drying. The dry vegetables are easily damaged by overheating, and best results are obtained in the final stages by the use of dry air the temperature of which is carefully controlled. Dry vegetables readily absorb water from air which is approaching the saturation point and no more than 30 per cent. saturation should be allowed in the final drying stage. When the dry bulb is 150°F. and the wet bulb 110°F., the air is about 30 per cent. saturated. If this air is discharged from the drier at 120°F. after cooling by evaporation, the percentage saturation is over 70.

Vegetables must be carefully prepared for drying so that there is no unnecessary hindrance to the passage of water to the air. As much surface as possible should be exposed to the air stream and the pieces should be thin. Very rapid drying is possible when the material is finely shredded, but this form is not always acceptable to the consumer. In the later stages of drying, the rate at which water moves to the surface is a very important factor in determining the rate of water removal. A very dry surface layer may hinder the removal of water from inside, especially if the pieces are too thick. The blanching treatment also will have an effect on the drying rate in the later stages. In most cases a correct blanching treatment accelerates the drying.

In conclsuion, it may be stated that a prolonged drying time usually leads to excessive deterioration in food values. A drying time of about 8 hours seems to give generally satisfactory results, although shorter drying times are preferable, particularly on the score of vitamin retention.

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SAFETY OF CANNED FOODS.

The following is the text of an announcement issued jointly by the Ministry of Food and the Ministry of Health, Great Britain, on January 7th, 1942.

Safety and Nutritional Value.

Nutritionally, canned food compares favourably with cooked. In order to ensure good quality, articles to be canned are selected with care and canned almost at once before they have lost any of their nutritive value. Fruit and vegetables are often processed within a few hours of being picked. Processing or sterilization is done with scientific care, and this results in less loss of nutritive value than when food is cooked on an open range.

Chemically, there is little risk of contamination from the tin of the can. Articles such as acid fruits, which might attack tin are packed in lacquered cans which give a high degree of protection. Nowadays little or no solder is used to seal the ends of food cans, and there is no risk of it contaminating the contents.

Bacteriologically, canned food is less likely to be infected than fresh food. Not only is it handled less; as most of the preparation is done by machinery, but it is sterilized after having been packed into the can. Cans are carefully tested by the makers before release to ensure that sterilization and closure are perfect.

Storage Life of Certain Canned Foods.

The life of canned foods varies with the article, the presence or absence of a suitable protective internal lacquer, and the humidity of the storage places. The last factor affects the external condition, since damp may lead to rusting and eventually to perforation. Cans are made from tin-plate, which is a pure steel sheet coated with pure tin.

Whenever a can of food is bought for storage, and not for immediate consumption, the date of purchase should be written in ink on the label.

Fruits. One year is the usual time for the storage of canned soft or stoned fruits kept in a cool place. If kept longer, the food value of the pack is not impaired, but it may appear less attractive, and the natural acidity of the fruit may attack any scratched or otherwise damaged parts of the lacquer of the can.

Honey and Jam: should keep at least three years in lacquered cans.

Vegetables: in lacquered cans store well for at least two years. If kept longer the appearance may become less attractive but the food value remains unchanged.

Baked Beans: in tomato or gravy do not deteriorate in appearance and keep longer than two years.

Fish: (especially sardines and salmon) keep for over five years as do most Meat packs (sausages, meat rolls, galantines, tongues, soups.) Canned Hams present a special problem in food preservation and the packers guarantee is usually only six months. If, however, after longer storage, the can is not bulged, the contents are usually sound.

Condensed Milk: keeps for varying periods according to the sugar content. Unsweetened milk keeps in good condition for about three years and sweetened full cream milk remains unchanged for six to nine months, after which it may become sugary, but this slow crystallization is in no way objectionable.

Dried Milk Powder: may be sold in packets or cans. Its keeping quality depends on the amount of moisture and butter fat which it may contain, and also on the method of packing. It should be used within a few weeks of receipt.

Damaged Cans: A "blown" can may be detected from the fact that one or both of its ends will be bulged and cannot be pushed back to its normal position. A rust hole, puncture, or a defective lid is also a sign of danger.

All blown and leaking cans should unhesitatingly be discarded, and even if a can looks sound the contents should not be eaten if they have an unusual smell or colour.

Open Cans: It is usual to turn the contents of a can into a glass or earthenware receptacle, but there is no health reason for doing so. Foods do not deteriorate more quickly in open cans than in glass.*

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* In unlacquered cans, however, corrosion of the interior of the open container may cause discolouration of the contents and an appreciable amount of tin contamination.

Cans of condensed milk, which if not to be used all at once are often opened by making two punctures in the lid, may be sealed by sticking two small pieces of paper over the holes by means of a drop of the milk. This will prolong the life of the contents.

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BACTERIOLOGICAL CONTROL IN FOOD PROCESSING.

Several aspects of bacteriological control in food processing are dealt with by P. S. Prickett and N. F. True in Food Industries, August 1940, p. 34. The principles set out are:-

(i) Start with clean raw materials.
(ii) Keep them clean during the manufacturing process.
(iii) Pack the finished product cleanly and in suitable containers.

The manufacturing process must be surveyed bacteriologically step by step from raw materials to the packed product to find where and how hygienic control measures must be used.

Many raw materials are now bought by food manufacturers subject to chemical and physical specification; microbiological specifications are likewise essential for certain types of raw materials and desirable for many.

In manufacturing processes a survey will likely disclose that certain steps cause a bacterial decrease, e.g. when boiling water is used for dissolving a raw material or where it is heated in the presence of water under steam pressure. Other stages will offer favourable conditions for bacterial growth such as pre-evaporating hot wells, continuously used pasteurizers, or vacuum pans and dryers.

Adequate knowledge of the types of organisms involved and the conditions governing their growth is essential in planning any changes to control such growth, for example the temperature-time relationships which are inimical to bacteria which are relatively easily destroyed at temperatures of the order of 140°F. may be very favourable to thermophilic bacteria which are capable of growing at this level.

In many cases, comparatively minor changes such as re-arrangement of piping, eliminating "pockets" and dead ends, re-adjusting certain temperature-time relationships, strict control of pH, and adding a raw material earlier or later in the process or in another form will be sufficient to change conditions favouring bacterial increase to those favouring their decrease.

The one essential ingredient common to all cleaning jobs is "elbow grease". A simple detergent plus scrub brushes of proper design, plus copious amounts of hot water will be found adequate for most cleaning jobs. Greater quantities of a disinfecting agent are required on equipment which is dirty. Hot water can be used, but steam is preferable as it is faster and more positive. With open equipment or that which will not stand pressure or where steam is not available or practical, chemical sterilization is preferable. Where steam is used, properly placed steam inlets, valves for air elimination and removal of condensed water, safety valves and pressure gauges are all essential for complete sterilization.

Small pieces of equipment impractical to steam in place can be steamed in large simple autoclaves or pressure steamers. To facilitate handling and eliminate contamination, chain hoists or overhead tracks can be used, and the workmen supplied with clean asbestos gloves so that the autoclaved equipment can be handled while still hot. If the steam pressure is released rapidly, the equipment is fairly dry when it is removed from the autoclave and similar results are obtained with the larger equipment that is steamed in place.

A programme of hygienic control does not necessarily require an increased number of employees, but it does mean that the production schedule and the employee's time and work are so arranged that his share of the cleaning and sterilizing procedures are an integral part of his work.

For the clean finished product, suitable containers clean both physically and bacteriologically must be used. This involves proper storage, inspection, and if necessary, cleaning of the containers.

Most important of all is the human factor which involves the education and training of the production personnel. The foreman in charge of each department should be responsible for the cleaning and sterilizing procedures in his department and in turn be responsible to the superintendent.

Laboratory men need to be in the factory almost constantly to inspect, confer, teach, and collect samples for bacterial analysis. The finished packed products ready for shipment to the consumer should be sampled frequently and the bacteriological results used as a final check on the hygienic control of the products.

The laboratory should be an independent department; it should make its recommendations regarding hygienic control to the superintendent and work through him. If the laboratory is to be held responsible for the hygienic control of the products its authority should equal its responsibility.

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USE OF HARDENING AGENTS FOR CANNED FOODS.

Some canned foods suffer from the disability that the heat processing which is necessary to sterilize them adequately has an undesirable softening effect on their texture. Improvement in texture of some of these foods can be obtained by the incorporation in the pack of small amounts of calcium salts.

Tomatoes: Calcium chloride has been proved to be effective in the case of tomatoes and its use as an "optional ingredient" has been approved by U.S.A. Food and Drug Administration. Purified calcium chloride in a quantity reasonably necessary to firm the tomatoes is permitted, but in no case more than 0.07 per cent. (calculated as anhydrous calcium chloride) of the weight of the finished canned tomatoes. This is equivalent to 6 grains of the anhydrous salt in each No.2 can of 20 oz. capacity. The requisite amount of calcium chloride may be added to each can in the form of solid pellets or dissolved in the juice or puree which is used to complete the filling of the cans.

According to U.S.A. regulations the label must include the statement: "Trace of calcium chloride added".

The increase in firmness of the tomatoes is due to prevention of the disintegration of the pectin cementing material in the tissues. A chemical reaction occurs with the formation of calcium pectate.

Shrimps: Permission to use calcium chloride in the canning of shrimps has also been granted by the U.S.A. Food and Drug Administration.

Addition of calcium chloride to the pre-soak produced best results as compared with addition to blanching brine or canning liquor. The pickled meats are pre-soaked for 35 minutes in cold 90° salometer salt brine containing 1 to 3 per cent. of calcium chloride. The meat is then blanched for 9 minutes in boiling 70° salometer salt brine, fan dried, graded, and filled into cans.

Potatoes: Although calcium salts do not appear to have been used for canned potatoes, their possible use is suggested from the results of experiments described by W.E. Pyke and G. Johnson in a Colorado Farm Bulletin (Colorado Station) 2 (1940) No.1.

It was reported that the addition of calcium salts to the water used for cooking potatoes checked sloughing through preventing disintegration of the pectin, and also controlled fracturing, although higher concentrations of calcium were required to prevent fracturing.

Naturally-hard water containing a rather high concentration of calcium salts prevented sloughing if the water was not too highly seasoned with table salt. In this bulletin, directions are given for preparing an artificially hard water using native gypsum or alabaster. Where gypsum is not available the use of soluble calcium salts is suggested, preference being given for calcium lactate and calcium sulfamate over calcium chloride on account of the tendency of the latter to absorb moisture. It was found that a mixture of 1 part of soluble calcium salt and 3 parts by weight of table salt added to the extent of 1 per cent. of the cooking water gave control of sloughing and a desirable salinity.

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COLOUR DEVELOPMENT IN CURED MEAT.

Although it is known that the characteristic reddish-pink colour in cured meats is due to the specific action of nitrite and that curing fluids containing this substance, without the addition of nitrate, will bring about the required colour change in the meat, there are certain advantages obtained by the inclusion of both nitrate and nitrite in the cures.

During relatively slow cures in pickles containing salt and nitrate, the development of colour in the meat does not commence until portion of the nitrate has been converted into nitrite as the result of bacterial action. By the inclusion of nitrite at the beginning of the cure, the colour change begins sooner and the curing time can therefore be reduced. If however, nitrate is excluded from the cure, there is the danger that the nitrite may be destroyed by bacterial action and there may then remain insufficient to bring about the change in colour throughout the meat. It is advisable therefore to include nitrite to promote early colour development, and nitrate to provide a reservoir for nitrite.

In rapid curing processes which are completed within a period of minutes or hours at temperatures between 140° and 212°F., nitrite is an essential constituent of the medium if the colour change is to be obtained during the short periods of exposure. Under these conditions the bacteria which can alter nitrate into nitrite are unable to grow and may even be destroyed at the high levels of temperature. Since no bacterial conversion of nitrate to nitrite is possible under these conditions, it may be considered unnecessary to include nitrate in the cure. There is however the possibility that some of the nitrate may be changed to nitrite as the result of chemical changes due to reducing substances in the meat.

In addition to providing a reservoir for nitrite, nitrate has an important effect in increasing the rate of penetration into the meat fibres of water carrying the other curing ingredients and thus indirectly hastening the colour change due to nitrite; this will apply in either slow or quick cures.

Apart from any specific curing effect, it has been shown also that nitrate assists in controlling the growth of putrefactive types of bacteria in the meat during curing and also renders these organisms more susceptible to destruction in the subsequent heat processes of canning.

To sum up, although the cured meat colour is due to the action of nitrite, it is desirable that the curing medium should also include nitrate, firstly to assist in attaining a more uniform and adequate colour fixation and secondly to assist in the control of those organisms which may cause serious spoilage.

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N O T E S:

1. THE CRYSTALLIZATION OF HONEY:

According to a report by R.F. Kardos in Kiserletiigyi Kozlemenyek Vo.42 (1939) page 289, the formation and growth of crystals in honey depends on the quality and quantity of the constituents especially on the presence of protective colloids. Crystallization can be prevented for 2 to 10 months by the addition of minute amounts of agar agar, 2 to 15 parts in 100,000 by weight of honey, or by heating the honey between 104°F. and 111°F. for 1 to 9 days. The retarding effect of heating was attributed to the absorption of the colloids present in the honey on the surface of the single molecules, or of sheets of crystals

2. DELUSTERING OIL-PRESERVED EGGS:

One of the drawbacks of oil-preserved eggs is their unattractive shiny appearance. By a Canadian patent 387, 429, March 12 (1940) to C.H. Parsons and L.D. Mink, assignors to Industrial Patents Corporation of Chicago, eggs are delustred by immersing for two or three minutes in water containing 5 to 10 per cent. of monosodium phosphate and 0.1 to 0.25 per cent of sodium dodecyl sulphate.

3. RANCIDITY IN BEANS:

In Food Industries Vol.12 (1940) p.125 an account is given of a method for control of deterioration in beans. During the preliminary soaking of beans in tepid water prior to cooking, an oil is given off which is absorbed by wooden soakers and adheres to metal surfaces. When these containers were not thoroughly cleaned, rancidity with deterioration of the product occurred. Satisfactory control was obtained by the use of glass-lined bean soakers.

4. TENDERNESS OF COOKED BEEF:

A report on the effect of metal skewers on cooking time and tenderness of beef has been made by S. Cover in Food Research, Vol.6 (1941) p.233. Paired roasts from the right and left sides of the same carcase were cooked to an internal temperature of 80°C. (176°F.) at the same oven temperature, 125°C. (257°F.), one with skewers and the other without. This oven temperature was the one which most frequently produced tender meat.

Skewers decreased the cooking time and losses of weight but increased the toughness of the three cuts used. The results supported the conclusion that longer slower cooking increases tenderness in meat as compared with shorter faster cooking. It is suggested that the increased tenderness was due to an increase in the conversion of collagen to gelatin during the time in which the meat temperatures exceeded 65°C. (149°F.)

NOTES (continued) -

5. PROCESSING AND QUALITY OF TOMATO JUICE.

As reported in Canning Age, Vol. 22 (1941), p. 92, by C.M. Merrill of the National Canners Association, variations in filling temperatures between 165° and 185° F. and in processing for specified times at various temperatures between 212° and 235°F. had a negligible effect on odor, colour, and flavour of tomato juice.

It was considered unwise for canners to risk serious spoilage losses by using low filling temperatures or inadequate heat processes, or both, when it was indicated that these factors did not have an appreciable effect in bettering the general quality of tomato juice.

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6. SODIUM NITRATE FOR SALTPETRE IN MEAT CURING.

Because of the recent prohibition on the use of Potassium Nitrate (salt petre) for meat curing, it will in future be necessary to make use of a substitute, Sodium Nitrate, which will be made available for meat curing in Australia.

Up to the present time this substance has not been used by Australian meat curers, but it has, for many years, been employed as a meat-curing agent in America where commercial practice has shown it to be an efficient and satisfactory substitute for saltpetre. The specific colouring effect on the meat is due in both cases to nitrite which is formed from the original nitrate, and several meat-curing firms in Australia are familiar with the use of Sodium Nitrite in quick curing processes.

It is recommended that the concentration of sodium nitrate in a particular cure should be the same as that of the potassium nitrate or saltpetre formerly used.

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