FOOD PRESERVATION QUARTERLY.

Vol. 2, No. 4. December, 1942.

CONTENTS

Issued by

DIVISION OF FOOD PRESERVATION

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

......

RE-ORGANIZATION OF THE DIVISION OF FOOD PRESERVATION.

Since the last account in the Quarterly of the Division's activities (Vol.1, No.1, 1941), an extensive re-organization has been carried out. All research projects with little or no relation to the war effort have been suspended, while several new, large-scale investigations of outstanding importance have been started.

In the early stages of the war, inadequate use of the Division's facilities and experience in food processing and distribution was made by the Australian authorities responsible for the supply of foodstuffs to the fighting forces and to the civilian population of Great Britain. During 1941, coincident with the growing recognition of the value of science applied to the war effort, the Division was called upon to carry out an increasing number of important investigations, particularly in the fields of canned and dried foodstuffs. Early in the present year, the volume of new work had grown to such proportions that a re-organization of the work was essential in order to make the best use of the limited laboratory facilities in the interest of the most pressing investigations.

To this end, practically all investigations on the cold storage of foodstuffs, previously comprising the bulk of the Division's work, were suspended. These were the cool storage of apples, pears, citrus fruits, peaches, plums, and grapes; cold storage of meat and meat products; handling, freezing, and storage of fish; and physical investigations on the cooling of meat.

The investigators so released were transferred mainly to the food canning and food dehydration sections in which most of the Division's staff is now working, and many new officers and assistants have since been appointed to these sections.

Special investigations on the canning of vegetables and of meat are being carried out by the canning section, which is also responsible for the examination, on behalf of the Service departments, of all canned foods and fruit juices produced in New South Wales. The main aim of all the canning studies is to provide immediate data to assist processors in meeting the rapidly increasing Service demands for canned foods, particularly those not canned in any quantity previously, and to provide day-to-day advice on technical problems which may be retarding production. In the canning of vegetables, particular attention has been given to the conditions of handling and processing favourable to high retentions of vitamin C, and to the heat processing required to produce commercial sterility in packs of various drained weights. The effects of the structure of the can seams and of different types of internal lacquering on the condition and keeping quality of various packs have also been major lines of investigation.

Fruit juices and other fruit products high in vitamin C are assuming considerable importance in the feeding of the fighting forces in areas remote from supplies of fresh food. The conditions of processing and storage necessary to the making of high quality products are being investigated and applied in the industry, particular attention being given to the possibilities of concentrated juices which will save considerable space and packaging materials.

The drying of foods effects considerable savings in space, weight, and refrigeration which are important considerations in war-time. Prior to the outbreak of war, fruit was the only foodstuff dried artificially in any quantity, but rapidly increasing production of dried egg powder, meat, and vegetables is now being undertaken. Unfortunately, there existed very little prior knowledge about the factors in processing and storage governing the quality of these dried products. In order to place these industries on a safe footing, therefore, intensive scientific studies have had to be made of all phases of these new industries. Sufficient progress has now been made, however, to indicate some, at least, of the major factors governing quality, and the application of this knowledge is being reflected in the better quality of products now being manufactured. In this developmental work, the dried foods section of the Division has played an important part since its inception early in 1941. In this work it has been greatly aided by close contact with similar laboratories in England and U.S.A.

The application to apples of certain thin waxy or oily films frequently results in a considerably increased storage life, particularly at moderate temperatures of the order of 50°F. This new method may have considerable application to the storage of apples in districts deficient in cold storage space and where it is too expensive to cool-store apples intended for canning and drying. The fruit storage section has been making an intensive study of the effects of surface coatings on apples, giving particular attention to such factors as variety, degree of maturity at the time of treatment, composition and thickness of the coating, methods of application, and temperature of storage. This section has also commenced investigations on the drying of apples, particular attention being paid to the effects of methods of sulphuring and conditions of drying upon the initial content and retention of sulphur dioxide.

A considerable proportion of the work of the physics section is being devoted to substitute containers and packaging materials in lieu of tin-plate. These investigations are being carried out in co-operation with the Council's Division of Industrial Chemistry. While no striking advances have been made, a valuable body of knowledge on the properties and limitations of available packaging materials, and coated and uncoated locally-manufactured containers has been accumulated.

....

HELP FROM THE LIBRARY.

Nicholas Appert, working at Massy near Paris, discovered the method of food preservation which was to become the foundation of the canning industry. He started his experiments in 1795, when the French Government offered a prize of 12,000 francs for a new method of preserving food for Napoleon's army and navy, and by 1806 his preserved meats, vegetables, fruits, and milk had been tried out by the French navy and found satisfactory. However, it was not until 1810 that he published his famous work, "The Book for All Households or the Art of Preserving Animal and Vegetable Substances for Many Years".

This was typical of the publication of scientific discoveries at this time. The early investigators worked individually as a rule, and communicated their results at long intervals in the form of books. The number of books was small and there was no means of finding out what books had been published on any particular subject. Nowadays, research workers are much more numerous and they publish their results as soon as possible in the proceedings and transactions of societies, journals, reports and bulletins of experiment stations, and as patent specifications. The scientific book has become a summary and review of the subject rather than a medium for the publication of original work.

The solution of many problems which arise in the food industries often requires a search through the literature on the subject, but the vast amount of printed matter makes the search difficult. Fortunately, to guide us through the maze of printed matter, there are now many good catalogues and indexes, which may be consulted in the public libraries and other large libraries, such as those of the technical colleges and universities. For English books there is the "Reference Catalogue of Current Literature", which lists, under subjects and authors, the books of over 600 publishers. This is supplemented by the Quarterly "Cumulative Books List". The United States has a similar comprehensive publication, "The Cumulative Book Index", which lists all books published in the English language according to authors and subjects. Another valuable index of books is the "Select List of Standard British Scientific and Technical Books" published by the Association of Special Libraries and Information Bureaux, and this is kept up-to-date by the Associations quarterly list.

Since it is not of much use to have a list of books but no means of obtaining them, it may be more helpful to consult the card catalogue at the public library, and ascertain from it what books are available there.

From books we may obtain a comprehensive review of the basic principles of the subject, which makes them helpful at the beginning of research, but for more detailed information, and information too new to have found its way into books, we must consult the smaller and more specialized papers in journals and bulletins. Most reference books come to our aid by listing some original articles, but few of them can attempt to include everything that has been written on any particular subject.

The "Index to the Literature of Food Investigation", published quarterly by the Department of Scientific and Industrial Research of Great Britain, abstracts and classifies articles from the main journals in this branch of applied science, but its value is lessened for speedy reference by lack of an annual subject index. Several of the other comprehensive indexes and abstracting periodicals such as "Chemical Abstracts", "British Chemical and Physiological Abstracts", "Biological Abstracts", and the "Industrial Arts Index", also abstract the journals of the food industries, but cannot be relied upon to cover the whole field. Of these, "Chemical Abstracts", which is published twice a month by the American Chemical Society, covers by far the greatest number of food journals, and still includes the journals of enemy and occupied countries. The abstracts of articles are classified only into broad groups, such as nutrition, foods, fermentation industries, but an author index is included in each number, and there is a good annual subject index, author index, and index to patents. As its service covers all the chemical industries, any articles of interest to those engaged in the food industries which have appeared in periodicals of a general nature, for instance in "Chemistry and Industry", will be included in the appropriate section. "Chemical Abstracts" does not, however, give an abstract of every article in each journal, but includes only those with new information and those likely to be of permanent value.

If difficulty is encountered in finding the essential published information relating to any particular problem, help may be obtained from the Research section of your Public Library, or from the Information Section of the Council for Scientific and Industrial Research.

....

SODIUM NITRATE IN MEAT CURING

Since the note on "Sodium Nitrate for Saltpetre in Meat Curing" was published in Vol.2, No.3, of the Quarterly, it has been ascertained that sodium nitrate has been successfully used as a meat-curing agent by at least one commercial firm in Australia and also by the Hawkesbury Agricultural College. According to information supplied by the Principal of this college, equally satisfactory results were obtained by using sodium nitrate at the rate of 5 per cent. of the weight of salt instead of 10 per cent. when potassium nitrate (saltpetre) was used. Theoretically, 85 parts by weight of sodium nitrate should supply the same amount of nitrate as 101 parts by weight of the potassium salt, but this comparison would not be strictly correct if the former salt, which is somewhat deliquescent, has taken up water from the atmosphere. From the practical standpoint, it would be advisable for meat curers to carry out small-scale tests with sodium nitrate at lower concentrations than the potassium nitrate solutions used in standard curing practice. Apart from consideration of the conservation of materials, it is necessary, under the State Pure Foods Acts, to keep the concentration of nitrates plus nitrites in cured meats below 14 grains per pound, when expressed as potassium nitrate, or 11.9 grains as sodium nitrate. Some confusion might arise from the use of the term "saltpetre" when applied to both nitrates of potassium and sodium, but the latter is usually distinguished by referring to it as "Chilean saltpetre".

DISCOLOURATION IN CANNED FOODS.

Darkening and other types of discolouration in canned foods are of frequent occurrence, and it is desirable that each type should be recognised and prevented as far as possible.

Some fruits and vegetables, particularly apples and potatoes, darken at cut surfaces due to the presence in the fresh product of active agents known as enzymes. As long as the tissue is intact the enzymes are confined within the cells and do not cause any darkening. On cutting, however, the cells at the cut surface are ruptured and the liberated enzymes cause darkening of the tissues in the presence of air. Immediate blanching in boiling water destroys the enzymes and, particularly in the presence of small amounts of sulphur dioxide, prevents further discolouration.

The most prevalent type of discolouration in canned foods is, however, that due to metallic contamination, particularly with iron or copper, which may be acquired during the preliminary processes of peeling, slicing, blanching, or from the can itself. This discolouration cannot be prevented by heat and is usually intensified by prolonged heat-processing. Sulphide blackening may occur in a variety of sulphur-containing products such as meat, fish, corn, peas, asparagus, cabbage, and onions. During heat treatment a slight decomposition of the protein or other natural substances occurs with liberation of small amounts of sulphide. This reacts with any dissolved iron or copper to form the black iron or copper sulphides.

The liberated sulphide may also react with the metals of the can to form tin or iron sulphides. Tin sulphide occurs as a purple, bronze, or black film closely adherent to the surface of the can; it is objectionable only from the point of view of the appearance of the can. But iron sulphide forms as a loose black deposit at points where the steel base-plate is exposed and it may stain the product.

Blackening due to iron sulphide has been particularly prevalent in cans of the hole-and-cap type and appears to be associated with the exposed iron at the cut edge of the hole.

Iron may also be derived from the equipment used for preparation of the product prior to placing in the can. The use of stainless steel, with its greater resistance to chemical action, instead of plain iron blanching vessels is a most important protective measure. The use of lacquered cans of the sanitary style should greatly minimize staining by iron sulphide.

In Australia an effective method commonly employed for the control of black staining of canned mutton in unlacquered cans is the inclusion of small amounts of lactose in the product, but the mechanism of control has not yet been determined.

Sulphide discolouration of canned corn has given a good deal of trouble in the United States of America, and a special internal coating enamel containing a small amount of zinc oxide was introduced by Bohart to overcome this trouble. The enamel tends to absorb any sulphides which are liberated, forming the colourless zinc sulphide instead of the black iron or copper sulphides.

Blackening due to copper sulphide is probably not so prevalent, because metallic copper is not so readily attacked as iron and the concentration of copper in the product is usually much lower than that of iron. However, due to the much lower solubility of the copper sulphide a very much smaller quantity of copper is needed to cause darkening. Copper sulphide can also be formed in foods which are too acid for the formation of iron sulphide. Bigelow and Miller found that one part per million of copper would cause discolouration in canned corn. Copper contamination is usually derived from copper vessels used in blanching. A case of discolouration in canned corned beef was found to be due to the use of copper rivets in the curing vats.

In addition to sulphide discolouration, traces of metal may react with the natural pigments and other substances in fruits and vegetables. The colouring materials are divided into the green and yellow pigments, insoluble in water, such as chlorophyll and carotene, e.g., in silver beet and tomatoes, and the water-soluble red and blue pigments due to anthocyanins, e.g. in berry fruits and beetroot. The insoluble pigments are not so liable to change, but traces of copper may react with chlorophyll and produce a very stable but rather unnaturally bright green. Traces of iron may appreciably affect the water-soluble anthocyanins, and tin has been found to modify the colour towards a purple shade. In addition, traces of iron very readily bring about discolouration in potatoes and certain varieties of apples, due to reaction with the natural tannin of these products.

Swede turnips are particularly liable to discolouration due to traces of iron, and in some cases not more than 20 parts per million of iron are required to cause appreciable darkening.

To reduce the risk of metallic contamination, it is advisable to blanch in stainless steel rather than plain iron vessels and to use efficiently lacquered cans. Efficient exhaust is important, because the above types of discolouration usually occur more readily in the presence of air.

A totally different type of pink discolouration has been found in canned pears, peaches, cabbages, and cauliflower, particularly after prolonged heat treatment. In these cases, no evidence has been obtained of metallic contamination, but the pink colour is possibly of anthocyanin nature and produced from colourless precursors during heat processing.

The pink discolouration in cauliflower may be minimized, and the commonly occurring dull leaden colour even eliminated, by blanching in citric acid solution. The specific procedure suggested is:-
Blanch 5-10 minutes at 185°F. in 0.5 per cent. citric acid. It is necessary to make up the loss of citric acid from the bath after 3 to 4 batches and to renew the bath entirely after 6 to 8 batches. The volume of solution in the bath should be approximately 1 gallon for each pound of cauliflower. In the final canned product, a pH not greater than 4.6 should be aimed at.

Discolouration of canned foods may also be due to bacterial spoilage. This is usually fairly obvious and can be identified readily, but a bacteriological examination may be necessary to establish the origin of the discolouration. The condition referred to as "black beets" which has been described by Cameron, Esty, and Williams of the National Canners Association of U.S.A. is an example of discolouration in under-processed canned beetroot due to bacterial action in the presence of an abnormally high amount of iron in the product.

....

THE INTERSTATE TRANSPORT BY RAIL OF CHILLED AND FROZEN BEEF.

INTRODUCTION.

Prior to the war, the refrigerated transport of beef to Sydney and Melbourne from various meatworks in and north of Brisbane, was effected by both rail and ship. Under normal conditions the sea transport of chilled and frozen beef was preferable because adequate refrigeration throughout the journey was available. Now, however, since transport by the sea route has practically ceased, the railways have to carry the whole load.

Under the best of conditions there was only a small margin of safety in the summer-time transport of beef over three railway systems from points several hundred miles north of Brisbane to Melbourne. It is, therefore, not surprising that some losses have occurred under the present conditions of congestion at points of loading and transhipment and of shortage of rolling stock.

It cannot be too strongly emphasised that beef is a highly perishable product which requires special care in its preparation, storage, and transport if satisfactory out-turn is to be achieved. It is the purpose of this article to outline the causes of spoilage, and to suggest methods by which this spoilage may be prevented.

SPOILAGE AND METHODS FOR ITS PREVENTION.

During the processes of preparation and handling of the beef in the meatworks, the exposed surface becomes contaminated with bacteria, yeasts, and moulds. The multiplication of these micro-organisms on the surface of the beef, the rate of which increases rapidly with increase in temperature, eventually results in spoilage and condemnation of the meat as unfit for human consumption.

The successful long-distance transport by rail of such beef therefore can only be obtained by strict adherence to the following conditions:

(i) Reduction to a minimum of the contamination acquired in the meatworks.
(ii) Prompt and rapid cooling after slaughter and dressing.
(iii) Maintenance of the lowest possible temperature during loading, transport, and transfers to other railway systems at break-of-gauge points.
(iv) Reduction to a minimum of the time both of loading and of transport.

(a) Reduction of Contamination.

In the processing of beef for the purposes of interstate trade, the utmost care should be taken to adopt every known hygienic precaution. This should be looked upon as nothing more than an insurance against loss by spoilage. Full information on the required technique is given in C.S.I.R. Food Preservation and Transport Division Circular No. 2.-P., on "Hygienic Methods for the Preparation of Beef in the Meatworks". No delay should be allowed in the transfer of the beef to the chiller, following dressing.

(b) Cooling in the Meatworks.

In the case of chilled beef, the lowest temperature to which it can be brought without freezing is about 30°F. It is obviously not desirable, in view of the type of temperature control existing in most meatworks, to attempt to chill quite down to this level. However, chilling should be carried as near this as possible, care being taken that the temperature of the beef at no time falls below $29\frac{1}{2}$°F. This chilling of the beef, from the surface to its deeper layers, should be accomplished as quickly as possible, preferably in two days, but certainly in not longer than three days. The rapid chilling of beef materially assists in securing a lower microbial count on the meat surface. Following this cooling, the beef should be dispatched with the least possible delay, since micro-organisms continue to multiply at chilled beef temperatures, even though much more slowly than at ordinary temperatures. The chilling should be conducted as far as possible in accordance with the principles laid down in Circular No.3.-P., of the same series as the one mentioned above, on "The Cooling of Export Chilled Beef".

In the case of frozen beef, and especially where long-distance transport in summer-time is involved, it is very desirable to reduce the temperature of this beef to a considerably lower level than that to which it is frozen for export in ships equipped to hold the beef at frozen temperatures. It should be borne in mind that every degree through which the temperature of the beef is dropped, is just so much added to the storage life of the beef. The more heat removed from the beef initially, the longer will the beef take to come to the state of thaw, other conditions being equal.

(c) Maintenance of Low Temperatures during Loading and Transport.

(i) Precooling the Wagons. By far the most desirable method of precooling railway wagons is the provision at meatworks of a refrigerated loading dock. This consists of a comparatively air-tight platform as close to the frozen and chilled stores as possible, into which the wagons which are to be loaded can be shunted. After the engine has moved out, and the doors of the dock closed, the wagons are cooled by the circulation of cold air. After this precooling, the loading can take place through refrigerated corridors from the chilled and frozen storage spaces into the cooled wagons. The whole train, upon loading, can then remain at its low-temperature loading platform until it is ready to move out. The use of this method would obviate, in the case of chilled beef, the very undesirable condensation of moisture which occurs, especially in hot humid weather, when transfer of the beef from a chiller to the railway wagon is made by motor truck.

Failing the above very desirable method of cooling and loading, a high degree of cooling efficiency can be attained by pumping cold air through the wagons, such air being obtained from refrigeration equipment which might be established at all important points where beef is loaded into railway wagons. As in the preceding method, this would extract more heat from the interior of the wagon than could usually be extracted by most methods of icing. It would of course take less refrigeration to accomplish this cooling of the interior of the wagon than would be involved in the use of a refrigerated loading platform, but in using this method, the beef would still be subject to rise in temperature during transfer from chiller or freezer, and during loading.

Precooling of a wagon by the use of ice should begin at least over-night if possible. The method is very inadequate under the best of conditions, and therefore, the longer the ice has to do its work the better the result is going to be. If equipment could be installed to circulate the air in the wagon during this process of cooling, the heat exchanges upon which the cooling depends would be greatly facilitated and the whole process more efficiently accomplished in shorter time. Unless the runs are short and the external air temperatures low, it is very desirable to make sure, immediately before the train leaves, that all the ice bunkers on the wagon are full of closely packed ice.

Another very desirable procedure when using ice, and one apparently not employed in Australia, is the addition of sodium chloride (common salt) to the ice, which has the effect of lowering the melting-point of the mixture. The addition of 33 parts by weight of sodium chloride to 100 parts of snow or finely pulverised ice, will drop the melting-point temperature to approximately minus 6°F. Since such a big amount of heat is taken up by ice to effect its conversion into water, the lower the temperature at which this is effected the more efficient will be the refrigeration, even though the life of the ice is decreased. It is probable that arrangements could be made, if necessary, to add ice to wagons at points other than those of origin, capital cities, and break-of-gauge. It may be that adequate provision has not been made on the wagons used for interstate beef transport to handle the high concentration of salty water which would result from the thaw of such a freezing mixture. It might be worth while, however, to take steps to have these wagons provided with such facilities, if found practicable.

In addition to the use of bunker ice, a considerable amount of added refrigeration can be obtained by the suitable disposition of "dry-ice" in the wagons. "Dry-ice", well known as such in the trade, is solid carbon dioxide. At atmospheric pressures this material "evaporates" to the gaseous form of carbon dioxide, without going through the liquid phase, at a temperature of approximately 144°F. below the freezing-point of water. The simplest existing method is to suspend about 100 to 150 pounds of "dry-ice", done up in hessian or cloth bags, from the hanging rails or from the ceiling in the case of "stacker" wagons which have no rails, distributing this at points along the longitudinal centre of the wagon, and as near to the ceiling as possible. This affords considerably increased cooling. In the case of transporting beef in a stack, whether frozen or chilled, placing "dry-ice" among the beef on the floor is an entirely undesirable practice. It does not allow the "dry-ice" to operate efficiently, and in the case of chilled beef, causes local freezing of the beef immediately surrounding it. In addition to the cooling, the liberation and accumulation of a sufficient concentration of carbon dioxide gas in a well sealed wagon is not without beneficial influence in retarding microbial growth. It is hoped that, before long, expanded metal boxes affixed to the ceilings of wagons will be provided as receptacles for the "dry-ice".

In cases where only non-refrigerated and poorly insulated wagons are available, all cooling must be accomplished by the use of "dry-ice". To compute the amount needed is somewhat difficult, but in cases where the amount of ordinary ice necessary for a certain wagon is known, the equivalent amount of "dry-ice" needed can be calculated on the basis of one pound of "dry-ice" for every six pounds of ordinary ice. To the figure thus obtained one might add another 25 per cent. of "dry-ice" as a margin of safety.

(ii) <u>Transfer from Chiller or Freezer to Railway Wagons.</u> The transfer of the beef from its frozen or chilled store to the railway siding is generally accomplished by means which do not afford any safeguards of refrigeration, such as by motor truck. In such transport therefore, every effort should be made to pack the beef just as compactly as possible and, if practicable, make the transfer at periods of the day when lower external temperatures prevail. Great care should be taken to prevent exposure of the beef to direct sunlight. With the realisation of the difficulties involved, the whole procedure should be organised so that both the transfer and the loading into the refrigerated railway wagons is accomplished in the very shortest time possible, and at the lowest possible temperatures.

(iii) Loading and Sealing the Wagons. Loading should be done under conditions where the whole of the wagon is protected from direct radiation from the sun, and at a platform which is not only properly surfaced and clean in itself, but where dirt and dust cannot be blown from adjacent area on to the beef during its transfer to the wagon. Other than when loading at a refrigerated loading dock, the doors of the wagon should not be opened until the beef is ready to be loaded. Failure to observe such procedure only results in the undoing of part of the precooling which has been effected.

In the case of chilled beef it is highly desirable that "hanger" wagons should be provided. It has been the practice to tie the quarters of beef to the bars instead of using hooks placed on or attached to the bars as is done on board ship. The argument seems to be that more effective hanging can be secured by this means. It would, however, seem worth while to investigate the possibility of providing "hanger" wagons with hooks and extension members where it is desirable to do a double hang. This is especially important at the present time when the rope used in hanging is in such short supply. The question whether in normal times loading would be better accomplished by the use of hooks and hanging members as against the use of rope, should be determined mainly on the basis of the time involved in loading by the respective methods.

In the case of frozen beef, it is desirable to place say two inches of dunnaging in the bottom of the wagon, filling up the spaces in between, and to a level slightly above that of the dunnaging, with good clean straw. This will, in effect, add to the insulation on one side of the stack, at least. In loading, every effort should be made to place the quarters so that the maximum density of the beef is attained. The more compact the stow the better is the chance that most of the beef will reach its destination in a thoroughly hard condition.

Another desirable point is that of making the wagon as air-tight as possible so that leakages of cold air may be prevented as far as is practicable. For this reason the sealing of the doors after loading, such as was done in connection with the lockers containing chilled beef destined for England, is very desirable. Admittedly, the chief reason for the very elaborate sealing in the case of ships' chilled beef lockers was to prevent the loss of carbon dioxide gas. However, if stout brown paper were pasted over the margins of the doors after they were closed, a definite contribution would be made toward maintaining lower temperatures.

(iv) Disposal of Wagons after Loading and Sealing. In the loading of chilled and frozen beef it seems quite common practice to shunt the wagons, immediately after loading, out into an open yard where they may have the sun blazing upon them, and where they are subject to any hot winds which exist, until the train is marshalled, often at the end of the day. It should be obvious that this procedure is one definitely antagonistic to the maintenance of low temperatures in the wagon. If arrangements could be made to shunt the loaded wagons into a covered loading platform where they would be protected from direct sunlight, the refrigeration potential of the wagon would be definitely improved.

(v) Unloading. At points of discharge from the train the wagons should not, under any condition, be opened until such time as unloading can be actively commenced. Every effort should be made to accomplish the transfer from the refrigerated wagon to the frozen or chilled store at destination in the quickest possible time.

(vi) Transfer at Break-of-Gauge Points. At break-of-gauge points it has been found that the most expeditious transfer from the wagon of one system to that of another is not always achieved. Therefore every effort should be made to plan the operations in relation to the relative positions of the two wagons concerned, the number of men employed, and the time of day during which the operation is conducted, so that the transfer is accomplished in the shortest possible time, and the beef subjected to the lowest possible temperatures which can be obtained. This transfer should be conducted at a covered platform, or during the night if possible.

CONCLUSION.

The necessity for reloading at break-of-gauge points adds to the difficulties of the satisfactory interstate transport of beef. The provision of insulated transport boxes, such as are employed abroad, which could be transferred from the under-frame of the wagon of one railway system to that of another, is a possible way out. Under present conditions, however, the provision of such equipment would be out of the question. This article therefore has discussed the problem only as it can be handled with existing resources.

In the preceding discussion, all points which can contribute to the satisfactory out-turn of the beef, either chilled or frozen, have been mentioned. Under extreme conditions the difficulties of satisfactory transport are very real, and such that it is only by giving due attention to every factor which can favourably influence the out-turn that good results can be expected.

Since this matter is one of interest primarily to Queensland, it should be pointed out that the Division's laboratory at Brisbane is always available to assist in any way possible in connection with the matter discussed in this article.

....

DEHYDRATED VEGETABLES.
Part 2.

THE TESTING OF DEHYDRATED VEGETABLES.

The testing of dehydrated vegetables involves

(1) general assessment of the appearance, odour, and flavour of the dried product;

(2) determination of moisture content;

(3) qualitative tests for enzyme activity (catalase and peroxidase);

(4) determination of the cooking time;

(5) assessment of the colour, flavour, and texture of the cooked product;

(6) determination of the vitamin content, in particular, ascorbic acid (vitamin C), carotene (provitamin A), and thiamin (vitamin B_1).

The dehydrated product should possess a uniform, well-marked, characteristic colour and should be free from partial or general discoloration, blemishes, or foreign materials. The product should possess a good, typical odour free from hay-like or other objectionable odours. With practice, the flavour of a dehydrated vegetable can be judged without reconstitution and it should be free from hay-like or other objectionable off-flavours.

MOISTURE CONTENT

The determination of the moisture content of dehydrated vegetables presents many difficulties. A rapid method is needed for process control as well as a more exact method to be used in the final checking of the product. Various rapid methods have been investigated and considerable progress has been made in the development of an electrical moisture meter which would make it possible to obtain results in a few minutes. Chemical methods are limited by the fact that many dehydrated vegetables decompose to a considerable extent at temperatures as high as 100°C. and give high values for the apparent moisture content. Heating the ground material in a vacuum oven at 70°C. has been adopted as the standard method. Heating the ground material in an air-oven, or water-jacketed oven, at 98°C. for 16 hours with suitable correction of the values obtained can be used as an alternative for rough checking. Further work on the determination of moisture by various methods is in progress.

ENZYME TESTS - BLANCHING.

The importance of the blanching process was emphasized in Part 1 and it was indicated there that the principal function of blanching for dehydration was the inactivation of enzymes. Tests for two enzymes, catalase and peroxidase, may be used to determine the efficiency of the blanching process. It should be realised that these are not the only enzymes responsible for undesirable changes which take place during processing and storage and they may not, in fact, be the enzymes vitally concerned. It has, however, been found that the inactivation of these enzymes can be used as an indication that other enzymes have been inactivated also.

In testing for catalase activity the blanched material or the partially reconstituted dried material is covered with 3 per cent. hydrogen peroxide; the evolution of oxygen indicates that the catalase system is still active and the material definitely under-blanched. In testing for peroxidase activity the material is covered with 0.3 per cent hydrogen peroxide and a 1 per cent. solution of guiaicol in alcohol added. The appearance of a reddish-brown colour on the vegetable indicates that the peroxidase system is still active and the blanching not complete.

COOKING TEST.

The cooking of dehydrated vegetables for testing purposes is carried out under standard conditions. The dehydrated vegetable is dropped into boiling water and the time required for the vegetable to become tender in texture measured from the time the water returns to the boil. The time required for dehydrated vegetables to cook without prior soaking should in no case exceed thirty minutes and in some cases should not exceed twenty minutes. When dehydrated vegetables are reconstituted and cooked the colour should be bright, and typical of the fresh vegetable, and the product should be free from blemishes. The product should possess the characteristic flavour of the fresh vegetable and be free from hay-like or other objectionable off-flavours and the texture should be tender but not mushy.

VITAMIN CONTENTS.

Vegetables are important sources of carotene (provitamin A) and ascorbic acid (vitamin C). Certain vegetables also contain significant amounts of thiamin (vitamin B_1) and most vegetables contain small quantities of riboflavin (vitamin B_2). The retention of vitamins in the dehydrated product can be high if proper attention is paid to the processing methods. In order to be able to improve the processing technique it is necessary to have available reliable chemical methods for the determination of these vitamins. Suitable chemical methods are available although all methods require further investigational work to improve their reliability and ease of application.

....

NOTES ON THE DEHYDRATION OF APPLES IN AUSTRALIA.

An increasing proportion of the Australian apple crop is now being dehydrated in those States which formerly exported their surplus, and it is anticipated that in 1943 approximately two million bushels of fresh apples will be dried to yield about 4,000 tons of dried fruit. In Tasmania, where most of the drying is being done, the principal varieties used are Sturmer, French Crab, and Cleopatra; in Western Australia the varieties Rokewood, Granny Smith, and Dunn's Favourite are being dried, and in South Australia the varieties which are suitable and available in sufficient quantity are Rome Beauty and Cleopatra.

SELECTION OF FRUIT.

Apples for drying should be mature and firm. Immature fruit has a poor colour and flavour after drying and over-mature fruit is too soft and often lacking in acid. Fruits showing rots, bruises, or bitter pit and fruits of very irregular shape should be discarded. The weight of whole fresh fruit required to yield one pound of dried apples varies from 10 to 15 pounds and depends on the variety, size, maturity, and condition of the fruit used. Later varieties have a lower drying ratio than earlier varieties and the most economical sizes are from 2½-3 inches in diameter. In fruit of these sizes there is less waste in preparation for drying, and the time and cost of preparation are considerably lower than for smaller fruit.

SULPHURING.

The apples are first peeled, trimmed, cored, and sliced and if there is any delay before sulphuring, the slices should be held in a solution of common salt of 3 to 5 per cent. concentration until sulphuring can be commenced. The sulphuring of apples for drying is essential to prevent browning during drying and storage and helps to preserve flavour. These are three main methods of sulphuring apples.

(1) Direct sulphuring by exposure to fumes of sulphur dioxide from burning flowers of sulphur.

(2) By dipping in solutions of sulphur dioxide or sulphites.

(3) By a combination of both methods.

Direct sulphuring, which is the commonest method, is used in Tasmania where the whole fruit, after peeling and coring, is conveyed through a long gas-tight box charged with sulphur fumes. The time taken to travel through the box is 30-45 minutes during which period the fruit absorbs about 2 grains of sulphur dioxide per pound. In Tasmania the fruit is usually insufficiently sulphured; the desirable dosage, before drying is from 7 to 10 grains of sulphur dioxide per pound in order that the dried apples will retain their colour and quality during storage. A much better absorption of sulphur dioxide is obtained if the fruit is sliced before sulphuring. The slices should be exposed to heavy sulphur fumes for 30 minutes either on a conveyor in a tunnel or on trays stacked in a sulphuring chamber.

In Western and South Australia the sliced apples are usually dipped in solutions of potassium metabisulphite and fairly satisfactory results have been obtained. The supply of this material is practically exhausted and investigations of possible substitutes have been carried out in this laboratory and in other centres. The whole question of sulphuring by solutions has been under consideration and the effects of the strength of the solution, the length of time in the dip, the drying conditions, and the reactions of different varieties of apples are being investigated in relation to the quality and sulphur dioxide content of the dried product.

Experiments carried out during 1942 have shown that a very satisfactory sulphur content can be obtained by dipping the slices in a solution of sulphur dioxide gas in water, but, as sulphur dioxide has a pungent and irritating smell, this method is not favoured commercially. Solutions of sodium sulphite which are normally alkaline in reaction can be used, but this solution is not very satisfactory because it tends to destroy the natural acidity of the fruit and it also intensifies the blue discolouration which develops in slices contaminated by iron. These effects can be overcome by acidifying to a pH value of 3-4 and this can conveniently be done by the addition of 66 ml. of concentrated hydrochloric or 18 ml. of concentrated sulphuric acid for every 100 grammes of anhydrous sodium sulphite in solution. Fruit treated with metabisulphite has a better quality and a higher sulphur dioxide content after drying than fruit treated with acidified sodium sulphite, but the latter material is the most satisfactory substitute so far discovered.

American workers have reported that a combination of dipping and direct sulphuring enables a considerably higher sulphur dioxide content to be obtained, but this method is only in the experimental stage in this country.

RETENTION OF SULPHUR DIOXIDE.

The residual sulphur dioxide content of the fruit after drying depends on the sulphuring method and on the temperature and humidity conditions during the initial stages of drying. In the case of direct sulphuring it has been found in America that significantly more sulphur dioxide is retained after drying if the slices are dipped for three minutes in a 2 per cent. solution of sodium citrate prior to drying.

In the case of the dipping method the amount of sulphur dioxide absorbed during the dipping depends on the thickness of the slice, the strength and hydrogen-ion concentration of the solution, and on the length of time for which the fruit is dipped. From this point of view and from other considerations, slices $\frac{1}{4}$ inch thick are satisfactory. The solution should be acid in reaction with a pH of about 3-4. It is better to dip the fruit for a short time in a strong solution than for a longer time in a weaker solution because time and water are saved and disintegration of the slices and leeching out of soluble materials from the fruit are reduced. The amount of sulphur dioxide absorbed is directly proportional to the concentration of the solution in which the fruit is dipped. However, the amounts absorbed and retained do not increase in proportion to increases in the time for which the slices are dipped, and experiments have shown that a dipping time of six minutes gives the best results. With longer times, increasing amounts are absorbed, but the amount retained after drying does not increase significantly.

It has been found also that the faster the rate of drying during the first hour, the greater will be the retention of sulphur dioxide during drying. This is indicated by the following results obtained at Homebush after dipping the slices for six minutes in a 2½ per cent. solution of potassium metabisulphite and drying to a moisture content of approximately 15 per cent.

1st hour		Thereafter		Drying Time	Sulphur dioxide content of dried slices	Sulphur dioxide lost during drying
Temperature °F.	Relative Humidity %	Temp. °F.	R.H. %	Hours	Grain/lb.	%
149	30	149	30	5 hrs.	8.7	79
149	10	131	30	3¼ hrs.	25.9	60
167	20	149	30	3 hrs.	10.4	58
167	10	149	30	3½* hrs	20.4	40

* This sample was over-dried to about 11% moisture.

With temperatures of about 120°F. and humidities of 30-40 per cent. in the early stages, drying has taken up to ten hours and the final sulphur dioxide content has been as low as three grains per pound with a loss of about 90 per cent. during drying.

Rapid drying is very desirable because it results in the daily capacity of the dehydrator and the retention of sulphur dioxide in the product being increased. In Tasmania, drying, which is done in kilns, is usually slow, often taking more than twelve hours. On the mainland, tunnel dehydrators with forced air flow are generally used. The fruit should be loaded into the hot end of these dehydrators so that it can immediately be subjected to high temperatures and low humidities in order to reduce the moisture content of the slices as quickly as possible. Such a procedure will best retain the sulphur dioxide in the slices and a slight case hardening during the early stages is also an advantage from this point of view.

In commercial practice the temperature at the loading end should not be greater than 165°F. and for rapid drying the relative humidity should not exceed 20 per cent. At the other end of the tunnel where drying is completed the temperature should be about 140°F; higher temperatures will "burn" the fruit. Although the air temperature at the hot end is high, the temperature of the slices will be lower because of the cooling effect of the rapid evaporation of water from them. If these conditions are observed and if the tray loading does not exceed 2 lb. per square foot, which is about the limit for even drying, a drying time of about four hours should be commercially feasible.

Although there is a prescribed upper limit of fourteen grains of sulphur dioxide per pound for dried apples sold in Australia or in the United Kingdom, many of the Australian samples have a sulphur dioxide content of less than one grain per pound and consequently they discolour rapidly during storage. A satisfactory sulphur dioxide content of up to ten grains per pound can be obtained if the slices are dipped for six minutes in a 1 per cent. solution of potassium metabisulphite and dried quickly as outlined above. If metabisulphite is not available the slices should be dipped for six minutes in a 1½ per cent. solution of sodium sulphite acidified as suggested above. The use of a 1½ per cent. solution is suggested on the basis of the rather limited experimental results so far obtained, but it should be satisfactory in commercial practice. The solution weakens with use and its strength should be determined frequently by titration with a standard iodine solution and brought back to the required value.

****

INDEX TO VOLUME 2, 1942.

INDEX TO VOLUME 2, 1942, CONTD.

••••••