

Home Freezing in Hawaii



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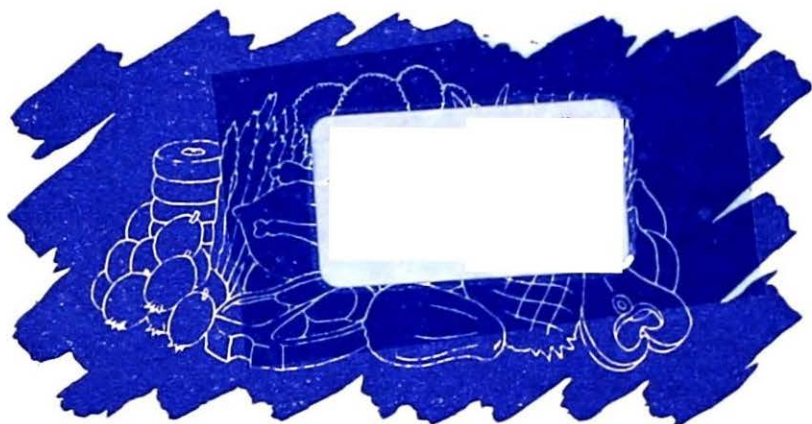
Circular 33

UNIVERSITY OF HAWAII AGRICULTURAL EXPERIMENT STATION
Honolulu, Hawaii

September, 1950

Home Freezing in Hawaii

**Fruits, Vegetables
Meats, Poultry, Game and Fish**



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FOREWORD

The first draft of this circular was prepared by Dr. Faith Fenton of Cornell University during the summer of 1949, when she spent 5 months in Hawaii as nutrition consultant with the Foods and Nutrition Department of the University of Hawaii Agricultural Experiment Station. Dr. Fenton also assisted with the revision as the work progressed.

The general aspects of the circular under the categories of fruits, vegetables, and meats, fish, and poultry are based on widely available scientific and technological information and on Dr. Fenton's extensive knowledge of the frozen food field.

Those portions of the circular referring specifically to island foods are based on 2 years of experimental work in the Foods and Nutrition Department of the Station. Much more work is needed before the best methods for freezing local foods can be stated with certainty. The techniques recommended here represent only the results to date but are published at this time so that others may have the benefit of our experience. As progress is made in the freezing of local products, additional information will be released.

The circular is designed especially for home freezing, but the basic principles are applicable to commercial freezing, and small commercial operators may find the publication a guide in obtaining high-quality frozen products.

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ACKNOWLEDGMENTS

Thanks are due a number of persons and agencies for their cooperation in obtaining materials for freezing and/or for their advice.

Mr. Colin Lennox and Mr. Albert W. Duvel of the Board of Agriculture and Forestry sent 10 varieties of mangoes from Kauai; Dr. A. J. Mangelsdorf, of the Experiment Station, Hawaiian Sugar Planters' Association, provided two varieties of mangoes from Molokai; Mr. D. T. Fleming shipped three varieties of mangoes from Maui; Miss Beatrice Krauss of the Pineapple Research Institute supplied pineapples and soursop; and a number of home producers furnished one or more samples of fruits for freezing. Mr. Glen Mitchell of Hilo gave suggestions for freezing game.

University of Hawaii Agricultural Experiment Station departments and personnel rendered the following assistance: the Vegetable Crops Department raised the edible-pod peas and broccoli especially for freezing experiments; the Plant Physiology and the Horticulture Departments furnished litchis and mangoes; Dr. W. B. Storey identified fruit varieties and supplied information regarding them; and Dr. Morton Rosenberg wrote the section on home preparation of poultry for freezing.

Staff members of the Home Economics Department and the Experiment Station served on the taste panel.

Appreciation for the art work is extended to Mr. Evan L. Gillespie.

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Freezing Fruits

The freezing of fruits to be used some weeks or months later has many advantages. Many of the fruits grown in Hawaii are seasonal. They can be frozen in season for out-of-season eating with the color, flavor, and food value practically unchanged. Fruits which are not seasonal—such as papaya and pineapple—can be frozen at the peak of their quality when they are most plentiful and lowest in price.

Fruits as a class are considered the most difficult of all products to freeze and use without radical changes in shape, texture, color, and flavor. Several of the tropical fruits are particularly difficult to freeze satisfactorily. Some become too soft, some toughen, some darken slightly, and some turn bitter. Tests have shown that frozen whole fruits, such as papayas, mangoes, and avocados, no matter how good the initial quality, are unsatisfactory after thawing. The flesh collapses and becomes soft and poor in flavor.

It is important that both the homemaker and the processor understand the principles involved in freezing preservation. These include the physical, chemical, enzymatic, and bacteriological changes which occur during the freezing and thawing of fruits. This knowledge is necessary to determine what fruits and fruit products can be successfully preserved by freezing and how these fruits should be prepared, packed, frozen, stored, thawed, and used.

Freezing foods is a time-saving method of food preservation because freezing requires from one-third to one-half the time canning does. Fruits may be frozen for later use in fruit juices, jams, conserves, and marmalades.

The sections on thawing and use of frozen fruits are applicable to both home and commercially frozen fruits.

Procedures which will help to obtain good-quality products are given on pages 22 to 47 in this circular. Most fruits can be satisfactorily frozen in some form if the proper precautions are taken.

PRINCIPLES OF FRUIT FREEZING

Physical Changes

The most troublesome physical change during freezing and thawing of fruit is that of texture. It is known that a uniform distribution of the ice crystals in the fruit aids in the retention of the texture. Texture change is largely due to the separation of water from the fruit tissues in the form of ice. Once separated, most of the water cannot be re-absorbed by the tissue.

The cellular breakdown or softening, which is characterized by loss in crispness and turgidity, is similar to the effect of cooking. Some fruits, such as papaya, are more subject to softening than are other fruits. Some varieties of a given fruit are also more subject to loss of texture than are other varieties.

One of the most effective ways of minimizing loss of texture in frozen fruits is to serve them before they are completely thawed and while some ice crystals remain.

Chemical Changes

Spoilage of foods, in general, is caused largely by enzyme activity, by the growth and activity of microorganisms, and by decomposition of certain of the constituents through reactions with each other, with the oxygen of the air, or with container walls. In freezing, the tissues are softened and the constituents are allowed to mix with each other. Furthermore, the natural resistance of the living plant tissue to the action of microorganisms has been broken down and the enzyme systems, which aid in the ripening, respiratory, and other life processes, have been interfered with.

Microbial spoilage: In sound fruits, microorganisms are present only on the surface. As stated previously, fruits ripened on the tree or vine should be prepared and frozen immediately. If they must be held, refrigerate them. The rate of growth of all microorganisms decreases as the temperature is lowered. Reducing the temperature to 40° F. as quickly as possible will markedly retard the growth and activity of microorganisms and reduce the danger of fermentation and spoilage of the fruit during storage and thawing.

Precooling the fruit is important for obtaining excellent products. This may be done by refrigeration, or, in the case of freshly picked berries and small fruits, by washing them in water containing ice.

Microorganisms are retarded in growth and activity during freezer-storage and many are destroyed. They are not all destroyed, however, and those remaining may increase in number and activity during thawing and during holding of the fruit after thawing. In frozen fruit, the softening of

the plant tissue permits a more rapid rate of spoilage after thawing than in the corresponding fresh fruit.

The type of spoilage naturally occurring in frozen fruits is fermentation. The changes are similar to those occurring in making fermented beverages, and the products are not likely to be harmful.

Enzymatic activity: Changes in color, taste, aroma, and ascorbic acid (vitamin C) content of fruits during freezing and thawing are caused mainly by oxidative enzymes. The discoloration of fruits and the resultant loss of characteristic flavor and the production of off-flavor are caused largely by oxidative enzymes. No browning will occur in fruit tissues until practically all the ascorbic acid has been oxidized to dehydro-ascorbic acid.

Low temperature retards, but does not entirely prevent, the activity of enzymes. To obtain high-quality products:

1. Select varieties which do not change readily in color, flavor, and texture.
2. Freeze mature fruit. Immature fruit is usually higher in tannins and other constituents involved in darkening; some contain compounds which become bitter during freezer-storage and thawing.
3. Handle fruit and fruit products quickly during preparation for freezing, packaging, and partial thawing and serving to minimize exposure to air. Cut directly into the sirup any fruit that is likely to discolor.
4. Add sugar or sirup. Sugar acts as an enzyme inhibitor and also as a means of excluding air. The latter is particularly true when the sugar is present in the form of sirup. It retards the development of yeasts and molds and thus reduces the danger of fermentation. Sugar protects the flavor, but heavy sugar sirups may mask the natural delicate flavors of frozen fruits to be used as desserts or breakfast fruits.

Non-enzymatic activity: Even though the enzymes may have been inactivated, auto-oxidation (self-oxidation) may occur. It is difficult to control but it can be minimized by the exclusion of oxygen and by the addition of sugar or sirup. Off-flavors and off-colors may be caused by auto-oxidation.

Sometimes a white fondant-like material, which after thawing appears as white patches, forms on the surface of frozen fruits during storage. This is due to the crystallization of sucrose.

Control of Physical and Chemical Changes

Addition of sugar and sirup: Some difference of opinion exists as to whether it is better to add sugar or sirup to fruits. Each has certain ad-

vantages and also certain disadvantages. Sirups not only give better protection of the fruits from air but also aid in the retention of their shape. They do, however, add water and thus dilute the fruit flavor. Dry sugar is sometimes satisfactory for short storage periods when it would not be for longer periods. The use to which the fruit is to be put often determines the way it is packed. Dry sugar is usually preferred for frozen fruits to be used in baking, particularly in pies; and in preserves, jams, jellies, and marmalades. Dry sugar avoids the large volume of water resulting from packing the fruit in sirup. Dry sugar is also preferred for purees which are in turn preferred for fruit ices, sherbets, ice creams, sauces, and beverages.

Sugar added dry is most satisfactory when it is uniformly distributed in pureed or crushed fruit, in fruit juices, or in sliced juicy fruits such as strawberries and plums. It should be used in packing slices of fruit only if the fruit is juicy enough to form a sugar solution that will coat the fruit. When dry sugar is used with whole berries or with fruit containing little juice, some of the sugar usually settles to the bottom. Neither sugar nor sirup penetrates deeply into the fruit; most of the sugar is likely to remain unabsorbed at the point of application.

Fruits tend to become more compact when mixed with dry sugar. As a result it is possible to pack more fruit in a carton than if sirup is used.

As stated previously, sirups protect fruit better than dry sugar, eliminate air pockets, act as precooling agents, and permit better retention of shape and sometimes of texture. Ascorbic acid and citric acid can be more uniformly distributed in sirup than in dry sugar. The commercial packer often prefers sirup because it is easier to add and gives a more attractive pack.

For preparation of sugar sirups see page 21.

Addition of acids: It is well established that the acidity of the medium inhibits enzyme activity. Because of their natural acidity, fruits, unlike vegetables, do not require blanching prior to freezing. The addition of citric acid to sweetened fruit purees and to the sirup in which fruit is frozen usually aids in color and flavor retention. Citric acid is the edible and flavorful acid of citrus, pineapple, and other fruits. Ascorbic acid and citric acid are used together to prevent the browning of some light-colored fruits.

If citric acid has been used, care must be taken to use the fruit before it is entirely thawed. Citric acid seems to increase the tendency toward discoloration and darkening of some fruits when they are allowed to stand after thawing.

Combinations of citric and ascorbic acid under trade names are now on the market.

Anti-oxidants or reducing substances: Ascorbic acid is widely used at present in packing cut fruit for dessert use. Since ascorbic acid is rapidly oxidized, it quickly reduces the oxygen dissolved in the sirup and maintains the compounds responsible for browning in the reduced form.

In addition to the prevention of browning, ascorbic acid has a striking effect on the retention of the natural taste and aroma of many fruits. It also aids in the retention of color in some thawed fruits. To obtain the full effect of the ascorbic acid, the fruit should be entirely covered with sirup or juice. The recommended proportion is 1 teaspoon (32 grams) of powdered ascorbic acid to 4 to 6 cups of chilled sirup. This amount of sirup is approximately sufficient to treat 12 pint packages or 9 pounds of fruit.

Ascorbic acid may be purchased at some drugstores in powdered form. Since it is unstable, it is best to purchase it just before it is to be used. If necessary to hold it, keep it in a closely stoppered bottle in the refrigerator. Mix the acid well with the sugar or dissolve it in the chilled sirup just before combining with the fruit.

The addition of ascorbic acid will increase the cost of each pint of frozen fruit slightly, but the acid helps prevent discoloration of cut fruit and will aid in the retention of the natural taste and aroma. Ascorbic acid has no characteristic flavor other than a mild acidity; it blends easily with fruit flavors, and is an important nutrient.

Heat treatment: Blanching (scalding) in steam, in boiling water, or in boiling sirup inactivates enzymes and thus prevents discoloration. A blanch which is sufficient to prevent browning, and still not precook the fruit, is not often attainable. Practically none of the tropical fruits except bananas discolor badly.

Blanching tends to give a cooked flavor and is not recommended for home freezing. Probably because blanching or precooking reduces the number of microorganisms present, it has been recommended for commercial preparation of fruit purees to be used in infant feeding. Although it is not necessary to add acids or anti-oxidants to blanched fruit, it is necessary to chill the product quickly, which adds to the work. Sweetened, raw, frozen fruits do not absorb much of the sugar so they tend to be less sweet on the inside than on the outside. In cooked fruits the sugar is more uniformly distributed.

QUALITY CONTROL OF FROZEN FRUITS

The chief factors which control the quality of frozen fruits are variety, maturity at harvesting, the speed from the time of harvesting to freezing, packaging, freezing and storage temperatures, length of storage, and time and methods of thawing.

Variety

The freezing of fruits starts with the garden or orchard. Not all varieties of a given fruit freeze well. Furthermore, varieties which grow well under the climatic and soil conditions of one locality, and produce excellent frozen products, may not grow well in another locality.

Other factors to consider in selection of a fruit variety for freezing, in addition to ease of culture, are freedom from disease and insect pests and, from the commercial standpoint, size of yield.

Work is now under way at the University of Hawaii to determine the varieties of mangoes, litchis, and papayas that will give the finest frozen products.

Color is one guide to the choice of variety. A strawberry which is red all the way through makes a better looking product than one which is light colored in the center. Color not only improves the appearance but usually is an indication of more intense flavor. Sometimes it is a direct indication of vitamin content; deep yellow color generally indicates a high vitamin A value.

In addition to deep color, a variety which produces a firm fruit when ripe and does not darken quickly when it is peeled or cut should be chosen.

Unfortunately no correlation has as yet been found between any chemical property studied and suitability of a variety for freezing. At present selection of variety is dependent on the results of palatability tests obtained from panels of trained judges.

Maturity

Fruit should be frozen at the peak of perfection. This stage is called optimum maturity, and occurs when fruits are firm-ripe but not mushy and are best for eating out of hand. Usually a better frozen product results from tree- or vine-ripened fruit.

Uniformity of ripeness in fruit to be frozen is important. Since some fruits do not ripen uniformly, several pickings are necessary for best results. Some fruits ripen on one side while the other side is still hard. If such fruits are used, the green part should be utilized in some other way and should not be frozen with the ripe portion. The green portions of some fruits become bitter during freezer-storage and thawing. When possible, choose varieties which ripen evenly.

Fruits which are soft-ripe and without signs of spoilage, but still good in flavor, may be used for fruit juices or purees.

Speed From Harvest to Freezer

Such fruits as blackberries, pineapples, plums, strawberries, mulberries, and Surinam cherries give best results if they are fully ripe when

harvested. They should then be prepared and frozen immediately. If this is not possible, the fruits may be held in the hydrator in the refrigerator for no longer than 24 hours.

At present, because of the fruit fly, it is necessary either to bag or to pick certain fruits before they are ripe. Such fruits, including mangoes, ripen with more uniformity and are of better quality if they are placed in a relatively cool, dark place rather than in the light or sun.

Packaging¹

Since sugar or sugar sirup is usually added to fruits, the pack is heavy and sturdy containers are required. Furthermore, since the freezing temperature of the liquid is lowered by the added sugar, the juice or sirup may not remain completely frozen at the storage temperature of the freezer and there is danger of leakage. Sturdy containers such as glass freezer jars, pasteboard tub-type or pasteboard cubical cartons, and aluminum containers are suitable. In each package leave sufficient space for expansion, because water contained in the fruit and in the sirup expands during freezing.

Fresh fruits usually contain air in the intercellular spaces in which ice first forms. Fruit contracts somewhat when frozen at relatively high temperatures but when frozen at low temperatures, which freeze the entire fruit rapidly, expansion occurs. An air space of 10 percent of the volume is sufficient when freezing occurs uniformly. This is usually from $\frac{1}{2}$ to $\frac{3}{4}$ inch at the top of the container. The container should be filled and the fruit frozen in such a way that it is completely full with no air spaces present when freezing is completed. A rigid carton aids in filling and in emptying.

Fruits which tend to float can be kept below the surface of the sirup by placing a piece of crushed waxed paper on top before the cover is put in place. The surface of purees can be protected from the air by covering with a piece of cellophane or pliofilm parchment (cut to fit) before the cover is adjusted. Covering the surface with a mixture of sirup and ascorbic acid is also effective, but dilutes the puree. Recommendations for handling banana puree are given on page 24.

Keep air pockets to a minimum because (1) air is a poor conductor of heat and slows the rate of freezing and thawing, and (2) air furnishes oxygen for undesirable oxidative changes.

The smaller the package, particularly the distance from the center to the outside, the more rapid is the freezing and the thawing.

¹ Additional information on packaging can be obtained from *Home Freezers and Packaging Materials*. Hawaii Agr. Expt. Sta. Cir. 27.

Freezing and Storage Temperatures

Some difference of opinion exists as to the best freezing and storage temperatures for fruits. Recent studies indicate that most fruits can be satisfactorily frozen and stored at 0° F. A lower freezing temperature may be necessary for some fruits. Those fruits which do not have supporting fibers and membranes similar to those of vegetables and meats lose firmness and collapse regardless of the temperature of freezing.

Avoid temperatures above 0° F. and fluctuating storage temperatures. The most obvious effect of fluctuating temperatures is moisture loss, which in a good package appears as frost or "cavity ice." When the temperature rises, moisture is "pulled out" of the food. When the temperature drops, this moisture freezes and is deposited as ice crystals on the surface of the food and on the inner walls of the package. In a poor package, the moisture is "pulled out" and deposited on the inner walls of the freezer cabinet and on the outside of the packages.

Thawing

Thawing is one of the most important, but probably the most neglected, steps in controlling the quality of frozen fruit as served. Changes in texture are the most troublesome changes occurring in freezing. These changes are more evident in fruits that have been thawed and removed from the package. Holding after thawing is equivalent to very long storage and accentuates any changes that may have occurred. This is noticeable in the development of the bitter taste in the green portions of fruits such as mangoes and the collapsing of strawberries.

During and after thawing, the fruits or pieces of fruit collapse, the intercellular gases escape, and osmotic action between the added sugar or sirup and the fruit juices occurs, all of which result in loss of volume. The fruit itself loses weight, and the drip increases. The greater the loss of weight from the fruit, the more its texture is disorganized. The juicy portions of some fruits tend to become soft and flabby and the fibrous portions tend to become tough. In general, fruit packed in sirup will retain its structure better than that packed in dry sugar.

Texture changes often show up before changes in taste, aroma, and color. Most frozen fruits lose texture, flavor, and color rapidly once they are thawed and removed from the package. However, a pint package of thawed fruit may remain at about 32° F. for almost 1 hour before the physical change in the fruit becomes marked.

To control loss of quality:

1. Pack fruits in small containers so that thawing is relatively rapid.
2. Thaw fruits in the sealed original container.
3. Open the package only when you are ready to serve the fruit.

4. SERVE THE FRUIT AT SUCH TEMPERATURE THAT SOME ICE CRYSTALS ARE STILL PRESENT WHEN IT IS EATEN.

Thaw frozen fruits to be used in pies only sufficiently to permit breaking them apart so that they can be distributed in the pie shell.

Fruits to be cooked for making jam, conserve, or marmalade require no thawing.

Fruits for jelly making should be thawed only enough to permit the juice to be pressed from them.

Fruits may be thawed by placing the unopened package:

1. In the food storage compartment of your refrigerator. One pint requires about 5 hours.
2. At room temperature. One pint requires 2 to 3 hours.
3. At room temperature in front of an electric fan. One pint requires less than 1 hour.
4. Water-tight packages in running cold water. One pint requires about 45 minutes.

Never thaw fruits in hot water. **THE RECOMMENDED METHOD OF THAWING IS IN THE REFRIGERATOR.** It results in the most uniform thawing and the best flavor and texture. Most fruits intended for use at breakfast are sufficiently thawed if they are placed in the refrigerator the evening before.

TYPES OF FROZEN FRUIT PRODUCTS

Whole Fruits

Only some of the small fruits such as blackberries and mulberries are satisfactory when frozen whole. Strawberries frozen whole become spongy and collapse upon thawing. Larger fruits such as avocados, mangoes, and papayas also lose texture and collapse upon thawing.

Sliced or Diced Fruits

Fruit may be sliced, diced, or cut into balls or finger-length pieces, according to the shape and size of the fruit, and according to personal choice. The pieces should be large enough to be attractive in appearance but thin enough to allow some penetration of sugar and expulsion of intercellular air from the tissues.

Fruits which are commonly sliced are mangoes, strawberries, guava shells, and pineapples. Fruits which are commonly diced are papayas and pineapples. Papayas may be cut in balls. Mangoes may be cut in finger lengths or cheeks.

Specific directions for freezing procedures for local fruits are given on pages 22 to 47.

Fruit Purees

Frozen fruit purees offer much promise in making fruit ices, sherbets, ice creams, beverages, various baked goods, jams, and sauces or "top-pings" for ice creams and puddings, and also for use as baby foods.

Fruits which tend to soften objectionably and to lose shape during freezing are especially suitable for purees. Very ripe fruits lend themselves to this method of freezing. Do not use overripe fruit which may have decayed spots, however, because off-flavors may develop in the frozen product.

Steam blanching just sufficient to inactivate the enzymes, followed by immediate chilling, has been recommended for some mainland fruits which are used for purees. Most Hawaiian fruits are satisfactory if pureed without blanching. They are likely to have a fresher taste and aroma, and a few have better color.

Some unblanched fruits lose appreciable amounts of ascorbic acid during pureeing; others do not. In any case work quickly and avoid undue exposure to air. Do not use any equipment which permits contact with copper or iron because they are destructive to vitamin C and sometimes to color. Equipment that crushes and rubs the fruit against a screen is likely to incorporate less air than does that which stirs or beats the puree. A cone-shaped aluminum press or food mill is satisfactory for home use.

Dry sugar and acids may be easily incorporated in purees in which they exert their full effect. Add them immediately after you puree the fruit.

Ascorbic acid in amounts up to 0.02 percent by weight of fruit may be added and mixed in with the sugar. The amount of sugar will depend upon the natural sweetness of the fruit and the degree of sweetness desired.

Velva Fruit

A frozen fruit puree dessert containing gelatin as a stabilizer has been developed in California.² It is prepared by adding 1 part of sugar by weight to 2.4 parts of pureed fruit and 0.2 percent citric acid for less tart fruits. The gelatin is mixed with 10 times its weight of cold water and heated to 180° F. to dissolve the gelatin. The dissolved gelatin is quickly and thoroughly mixed with the sweetened puree. During the addition of the gelatin, the puree must be stirred to prevent the gelatin from lumping. The mixture is frozen in an ice cream freezer to obtain a smooth texture and to increase the volume about 100 percent. Velva Fruit may be frozen and stored as such, or it may be made as needed from any frozen fruit

² U. S. Department of Agriculture Western Regional Research Laboratory, Albany, Calif. Specific recipes for Velva Fruit are given on page 44.

puree. Storage of Velva Fruits for longer than 3 months is not recommended.

Fruit Juices

A number of fine tasting fruit juices can be made and frozen. Usually only those fruits are used for juice which are soft and from which the juice can be easily extracted. Among the tropical fruits are included pineapple, carambola, soursop, and passion fruit.

To retain flavor and prevent separation, frozen juices should be thawed rapidly and used immediately.

Frozen Fruit Pies

Frozen fruit pies have proved to be one of the most popular of the frozen ready-to-cook foods. This is true of both the home-frozen and commercially frozen products. The pies can be made when a particular fruit is at the peak of its quality and most plentiful. Although excellent pies can be made from most frozen fruits, there is often an advantage in having a pie ready to "pop in the oven" at a moment's notice. Freezing the pie, rather than freezing the fruit and later making the pie, also saves some handling of the fruit.

Any fat suitable for making pastry for a fresh pie may be used. Since the pastry is to be held in storage and the development of rancidity is possible, use fat of initial high quality. Slightly less fat may be used because freezing tenderizes pastry.

Pies are more satisfactory if they are frozen before baking. Pies baked before freezing tend to be more like day-old pies. There is no advantage, from the management and fuel standpoints, in raising the temperature of a pie in a 450° F. oven, cooling it to room temperature, and then lowering it still more in a 0° F. freezer cabinet, and later raising it to serving temperature.

Pie tins of various compositions—ovenware glass, aluminum, and enamel (free from chips)—may be used. If one does not wish to keep standard pie tins in dead storage, paper pie plates may be used. If a disk of aluminum foil is placed in the bottom of the paper plate before putting in the crust, the bottom crust may brown better. Paper plates having a metal rim are satisfactory and fairly sturdy.

Pies may be wrapped either before or after freezing. Place them in the coldest part of the freezer, on a primary freezing area if possible. When they are frozen, wrap in cellophane or similar wrapping material, seal, and cover with stockinette. After the frozen pies are wrapped, stack them for storage, or if desired, place them in cartons and stack.

Pies placed in the oven while still solidly frozen are better in quality than are those permitted to thaw prior to baking. Thawed pies show more

tendency to have a juice-soaked undercrust and a slightly stale flavor. Omitting the thawing is also better management. If it is necessary to hold a frozen pie before baking, keep it in the refrigerator.

Bake the frozen pies as you would the corresponding fresh fruit pie but increase the baking time. Satisfactory baking temperatures are (1) 450° F. for 10 minutes and then 350° F. for the remainder of the time, or (2) a constant baking temperature of 400° F. for the entire time, which is usually 45 to 60 minutes, depending chiefly on the size of the pie.

One of the most common faults in frozen pies is an underdone lower crust. Use the same precautions to avoid this that you would in baking a fresh fruit pie: (1) do not have the lower crust too thick, (2) place the pie in such a position in your oven that the bottom receives sufficient heat.

Any possibility of an underdone, juice-soaked lower crust can be avoided by omitting it, that is, making a deep-dish fruit pie. Use a deeper pan, preferably of glass ovenware, grease it, add the fruit, cover it with pastry, and freeze. Do not use a paper plate for freezing one-crust pies. Any of the recipes given for two-crust pies may be used by cutting the amount of pastry in half and by increasing the amount of fruit filling.

The juice in some frozen pies has a tendency to boil over in the oven. Again, take the same precautions you would in baking a fresh pie:

1. Do not have too much filling for the depth of the pie pan.
2. Make a good seal between the upper and lower crusts.
3. Make an opening in the upper crust for the escape of steam as soon as the pastry is soft enough to cut without breaking (after about 5 minutes of baking). Cutting the upper crust is necessary even though openings were made before freezing.
4. Change the position of the pie in the oven if necessary.
5. Lower the temperature if necessary.

EQUIPMENT FOR HANDLING FRUIT

In addition to sugar, chilled sirup, citric acid, and ascorbic acid, plenty of ice and the proper packaging and labeling material, the following ordinary kitchenware is needed:

1. A kitchen scale.
2. Sharp stainless steel knives for capping berries and paring fruit.

For firm fruit, saw-toothed blades are often more efficient than smooth-edged blades. A saw-toothed knife is also efficient in removing the pulp which clings to the seeds of ripe mangoes. The peeler with the loosely swung, slotted knife is very efficient for paring some fruits.

3. The necessary bowls and pans in which to wash, pare, and slice the fruit, and to mix the fruit with sugar.
4. A wooden spoon for mixing the fruit with sugar.

Use earthenware, stainless steel, glass, and high-grade aluminum when working with fruits, especially crushed fruits, juices, and purees. Fruit acids affect tin and many fruits darken and acquire a metallic flavor from tin utensils. Copper is destructive to vitamin C. Iron darkens fruits and hastens the destruction of vitamin C. Enamel utensils may be used if they are not chipped, exposing the iron base.

ORGANIZATION OF FREEZING PROCEDURES

If you do not have help in freezing, organize your work so that it is possible to work quickly with the fruit after it reaches your kitchen and to place it in the freezer immediately. Make your sugar sirup in advance, preferably a day ahead, cool, and hold it in the refrigerator until it is needed.

Be sure that you have the correct containers and enough of them. Label each one completely and accurately in advance.

PLAN FOR FREEZER PRESERVATION

Make a year's plan on paper of the amount of fruit you will freeze. The quantity will depend not only on the family needs but on the approximate amounts that can be stored in the space available. Without a plan, the freezer may be filled with the first foods available. A fairly rapid turnover of frozen foods is necessary to obtain the maximum value of a freezer.

Plan to use all of each seasonal frozen fruit a few weeks before the new crop. If you are still using the fruit in the frozen state you will lose some of the zest of the new crop.

PREPARATION OF SUGAR SIRUP

Sugar sirup is made by dissolving sugar in boiling water in the desired proportions. Mix the sugar and water and bring them to a full rolling boil.

TABLE 1. Proportion of Sugar to Water in Sirups*

Concentration desired Percent	Cups of sugar needed for 1 pint (2 cups) of water
20	$\frac{1}{2}$
30	1
35	$1\frac{1}{8}$
40	$1\frac{3}{8}$
50	$2\frac{1}{2}$

* Proportion of water and sugar recommended by Tressler, Evers, Long in *Into The Freezer—And Out*. The Avi Publishing Co., New York, 1946, p. 128.

Directions For Freezing Some Hawaiian Fruits and Suggestions For Their Use

AVOCADOS

Avocados are difficult to process. Heating causes the development of bitter flavors, and freezing softens the already tender pulp, causing it to lose form and flavor.

Avocados frozen whole, or in slices or pieces in sugar or sirup, are not satisfactory because they lose flavor, and become soft and somewhat discolored. Only one method of preparing frozen avocados—as a puree—has been found successful to date. Purees frozen without sugar and acid have poor flavor.

AVOCADO PUREE

Preparation: Select fully mature, but firm, fruit. The rind should be of a good, uniform color with no dark blemishes. Wash the fruit and cut it in half. Remove the large seed and membrane. Scoop out the pulp, keeping the rind shell intact. Mash the pulp well, or if it is fibrous, puree it. One avocado furnishes from $\frac{1}{2}$ to 1 cup of puree.

To 1 cup of puree, add approximately $1\frac{1}{2}$ tablespoons of sugar and 2 teaspoons of lemon juice. Make a smooth paste, blending the sugar and lemon juice with the pulp. Put the paste back into the shell halves and freeze. As soon as the halves are frozen, place together again after putting two pieces of cellophane between them; wrap them in moisture-vapor-resistant paper, or in metal foil, and package in waxed cartons. If desired, the flavored avocado puree may be packed as individual servings in plastic cups and served in them. It may also be frozen in $\frac{1}{2}$ - or 1-pint cartons.

Serving: Allow the frozen avocado halves to thaw *partially* in the sealed original wrapping in the storage compartment of the refrigerator and serve as a dessert.

The puree may be used in making ice cream, sherbet, molded salads, sandwich filling, and salad dressings. In using the frozen avocado puree in any recipe calling for unfrozen mashed avocado, correct for the amount of sugar and acid present in the frozen puree. For example, if the recipe calls for 1 cup of puree, decrease the sugar in the recipe by $1\frac{1}{2}$ tablespoons and the lemon juice by 2 teaspoons when substituting 1 cup frozen puree.

AVOCADO GELATIN SALAD

YIELD: 6 servings

1 package lemon-flavored gelatin
 $\frac{3}{4}$ cup hot water
2 tablespoons lemon juice
1 teaspoon salt

$\frac{1}{2}$ cup mayonnaise
1 cup frozen avocado puree, slightly
defrosted
 $\frac{1}{2}$ cup cream or evaporated milk,
whipped

Dissolve the flavored gelatin in hot water and cool it. Add lemon juice and salt, chill. When the mixture begins to thicken, fold in mayonnaise, avocado puree, and the whipped cream, which have been blended together. Pour the mixture into a mold and chill. Unmold on lettuce and garnish with orange and grapefruit, or tomato sections.

Frozen avocado prepared as directed has been used successfully in Avocado Milk Sherbet and as Avocado Sandwich Filling, which may also be used as a dip for potato chips, crackers, and sliced cucumbers. For recipes for these dishes and others using avocado, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

BANANAS

Bananas are available in Hawaii the year round, but at times many households have a surplus, especially if they grow bananas in home gardens.

To date a limited number of freezing experiments have been carried out with Bluefield and Cavendish (Chinese) bananas (the two most widely used eating varieties in Hawaii), Brazilian (often called "Apple" bananas in Hawaii), and two varieties of cooking bananas.

Some consider Brazilian bananas superior to the Cavendish and Bluefields because they discolor less and hold their shape better when frozen. Their superiority for freezing is probably related to their original firmer texture, greater acidity, and higher ascorbic acid content than the two popular eating varieties. Because of their firm texture, Brazilian bananas do not make good purees.

Bananas have a marked tendency to darken and to lose texture. They also tend to develop off-flavors. Consequently they are not satisfactory when frozen as slices in sirup, in fruit cups, or even in frozen gelatin or pectin salads. The purees, even though treated with sugar and acid, may darken on the surface and should, therefore, be used within a few months and thawed quickly.

If eating bananas are often used in such products as banana cake, bread, and muffins, it is time saving to puree or mash a large quantity and freeze it in small cartons for future use as directed below. Some darkening (oxidation) takes place when bananas are pureed for immediate use so that a little darkening during freezing is not too serious if the flavor is not impaired.

Experiments to date indicate that banana puree should not be kept frozen longer than 6 months and a shorter period is advised.

Cooking bananas make excellent frozen products if cooked before freezing.

Preparation: Use fully ripe but firm bananas of good color. Remove skin and adhering strings.

BANANA PUREE

Mash or puree bananas, working quickly to avoid darkening of the fruit. Two to three bananas yield 1 cup puree. Add $\frac{1}{2}$ teaspoon of ascorbic acid powder to 1 pint of 20 percent sirup. Add 1 to 2 tablespoons of sirup for each banana used. Mix well, package, and freeze immediately.

If the puree is to be used in beverages, transfer it to an ice-cube tray. Cover the surface snugly with cellophane, pliofilm, or polyethylene paper to prevent discoloration of the surface of the fruit during freezing. As soon as the puree is frozen, remove it from the tray and wrap each cube snugly in cellophane and seal. Pack the wrapped cubes tightly in rectangular, waxed, pasteboard cartons, and store. Heat seal the inner bag of the carton.

If the frozen puree is to be used in ice creams or banana bread, freeze it directly in pint cartons.

Frozen banana puree may be used in many recipes calling for mashed bananas. Do any necessary thawing quickly and use the puree frozen or partially frozen whenever possible.

CHOCOLATE-DIPPED BANANAS

Because of their firmer flesh, Brazilian bananas are recommended.

Preparation: Peel bananas and dip in ascorbic acid solution (1 teaspoon of ascorbic acid to 1 pint of boiled chilled water). Insert the end of a sanitary wooden stick lengthwise in each banana. Sticks $3\frac{1}{2}$ inches long and $\frac{3}{16}$ inch in diameter, packed 20 in a bag, may be purchased at dime and variety stores. Place the bananas on an aluminum tray or cookie sheet and freeze them immediately. When frozen, dip each banana in melted coating or dipping chocolate. The amount of chocolate required will depend on the size of the bananas and the thickness of the coating. Usually 1 pound will coat from 12 to 18 bananas. Melt the chocolate over hot, *not boiling*, water. Beat gently until the chocolate feels a little cooler than the hand, or registers 80 to 85° F. on a candy thermometer. Grasping the banana by the skewer, move it around quickly until it is covered with chocolate. If the chocolate slides off, you are working too slowly, or the chocolate is not the correct temperature. After removing the banana, hold it for a few seconds until the chocolate has hardened slightly; then place it on waxed paper. When sufficient bananas for one carton are dipped, wrap each individually in moisture-vapor-proof paper or metal foil; seal, place in carton, and return to the freezer.

Note: Dipping the bananas in ascorbic acid solution minimizes browning and gives an acid flavor. Bananas expand during freezing. Therefore it is advisable to freeze them before dipping them; otherwise the chocolate coating is apt to be broken during freezing.

Serving: Serve the bananas while they are still frozen. Like ice cream which has been stored in a freezer, the bananas should be allowed to soften somewhat. Usually 10 to 15 minutes in the refrigerator is sufficient. Frozen chocolate-dipped bananas are somewhat waxy in texture but this texture is very acceptable, providing the bananas are eaten while they are still partially frozen.

BANANA MILK SHAKE

YIELD: 1 serving

$\frac{1}{3}$ cup frozen banana puree or 2 banana cubes, slightly de- frosted	$\frac{1}{4}$ teaspoon vanilla
$\frac{3}{4}$ cup fresh, diluted evaporated, or reconstituted dried whole milk	Few grains salt
	1 teaspoon sugar

Add the other ingredients slowly to the slightly defrosted puree, mixing well with rotary or other beater, or use electric mixer or Waring Blendor.

Variation: Add 1 egg to the above mixture and beat it in well.

BANANA-GUAVA NECTAR

YIELD: 6 servings

3 cups frozen banana puree, slightly defrosted	1 cup water
1 cup frozen guava juice, slightly defrosted	$\frac{1}{2}$ cup sugar

Break up the slightly thawed fruits in an electric mixer. Then add water and sugar, and mix well. Garnish with mint and serve.

Note: Pour the mixture over cracked ice, if desired.

BANANA-PINEAPPLE SHERBET

YIELD: 6 servings

$\frac{1}{2}$ to $\frac{3}{4}$ cup confectioners' sugar	6 tablespoons lemon juice
$1\frac{1}{2}$ cups frozen crushed pineapple, slightly defrosted	$\frac{1}{2}$ cup orange juice
$1\frac{1}{2}$ cups frozen banana puree, slightly defrosted	$\frac{1}{8}$ teaspoon salt
	2 egg whites

Dissolve the sugar in the pineapple, and add the other fruits. Freeze the mixture in an ice cream freezer until it is almost firm.

Add the salt to the egg whites and beat until stiff. Add to the fruit ice and continue turning the freezer until the sherbet is firm.

A less smooth texture can be obtained by freezing the mixture in a refrigerator tray, stirring every half hour until completely frozen.

BANANA BREAD

YIELD: 1 medium size loaf

1/3 cup shortening
 2/3 cup sugar
 2 eggs, beaten
 1 1/4 cups sifted flour

2 teaspoons baking powder
 1/4 teaspoon soda
 1/2 teaspoon salt
 1 cup frozen banana puree, slightly
 defrosted

Cream the shortening and add the sugar. Add beaten eggs and mix well. Sift the dry ingredients together and add them alternately with the banana puree. Bake in a greased loaf pan at 350° F. until done (about 1 hour).

Note: This bread may be made with fresh bananas and then frozen. Cool the bread after baking, seal in cellophane, freeze, and box. For serving, reheat it in the sealed original wrapping at 350° F. for 10 to 20 minutes, depending upon the thickness of the loaf.

BAKED BANANAS

YIELD: 4 servings

4 cooking bananas
 1/4 cup orange juice
 2 tablespoons brown sugar

1/2 teaspoon cinnamon
 1 tablespoon butter or margarine

Peel and scrape the bananas. Cut them into halves, place them in a baking dish, and sprinkle them with orange juice, sugar, and cinnamon. Dot with fat and bake at 350° F. for 45 minutes, or until almost tender. Chill immediately, package, and freeze.

To serve, heat to serving temperature in a covered casserole in a 350° to 375° F. oven.

BANANAS WITH COCONUT SAUCE¹

YIELD: 6 servings

4 cooking bananas
 2 tablespoons sugar
 1 tablespoon cornstarch

1/8 teaspoon salt
 1 cup milk
 2/3 cup grated coconut, fresh or frozen

Place whole, unpeeled bananas in boiling water and cook until soft (20 to 30 minutes). Remove skins and cut bananas lengthwise. Make sauce by mixing sugar, cornstarch, and salt, and adding milk gradually. Cook until the mixture is thickened. Add coconut and pour over the bananas. Chill, package, and freeze.

Thaw and serve as a dessert.

BLACKBERRIES

The wild blackberries which grow at the higher elevations on Hawaii and Kauai make an excellent frozen product.

Select fully ripe berries. Wash them in water containing ice, or in running cold water. Remove stems and any red or green berries. Place berries in suitable sturdy container, cover with 35 to 50 percent sirup,

¹ Adapted from Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

and seal. Or pack with dry sugar in the ratio of 1 part sugar to 4 or 5 parts berries by weight.

Frozen blackberries do not make a very satisfactory dessert sauce, but they do make excellent pies, cobblers, jams, and juice.

BLACKBERRY PIE

YIELD: 6 servings

¼ to ½ cup sugar (according to sweetness of frozen fruit)	2 to 3 cups frozen blackberries, partially defrosted
2 tablespoons quick-cooking tapioca	1 tablespoon butter or margarine
1 tablespoon lemon juice, if desired	

Mix dry ingredients, lemon juice, and 1 cup juice drained from the berries. Pour this mixture over the berries and mix carefully. Pour into pie shell. Dot with fat. Cover with top crust or lattice crust. Bake at 450° F. for 10 to 15 minutes; reduce the heat to 350° F. and bake until the crust is a golden brown (about 25 minutes).

Note: If there is too much juice in proportion to berries, remove some and use it in iced drinks or sherbets.

CARAMBOLA

This fruit has a tough peel which is not softened by freezing. Therefore, if the slices are frozen, they had best be used as a garnish only.

Select fully ripe fruits. Wash them in running cold water. Slice the fruit crosswise, and pack in 35 to 50 percent sirup; or puree the fruit and add sugar in the ratio of 1 part sugar to 8 parts of fruit by weight.

The star-shaped slices may be used for salad garnishes. The puree may be added to fruit punch or used in sherbet.

CARAMBOLADE

YIELD: 6 servings

2 cups frozen carambola puree, slightly defrosted	2 cups cold water
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Mix fruit and water well and pour over cracked ice. If desired, ¼ cup sugar may be added.

SOUR CARAMBOLA SHERBET⁴

YIELD: 6 servings

1 teaspoon gelatin	1½ cups frozen carambola puree, slightly defrosted
1 tablespoon cold water	1½ tablespoons lemon juice
¾ cup sugar	
2 cups boiling water	

Soak gelatin in cold water. Add sugar to boiling water and boil for 5 minutes. Remove from heat and add it slowly to the gelatin, stirring until the gelatin is dissolved. Cool to lukewarm, add fruit juice and puree, and freeze.

COCONUT

Grated coconut makes a very satisfactory frozen product. It is good

⁴ Adapted from Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

management to grate and pack the coconut from a number of nuts at one time and package the product in containers of several sizes for future use.

Preparation: Break the husked coconut into halves by pounding the shell around the circumference. Grate the meat from each half shell, using a Hawaiian grater,⁵ or peel off brown skin and either grate the pieces on an ordinary grater—a very laborious process—or put them through a meat grinder. One coconut yields about 2 cups of grated coconut, tightly packed.

The grated coconut may be packed plain or mixed with sugar in the proportion of 1 part of sugar to 10 parts of grated coconut by weight. Higher proportions of sugar give too sweet a product for most uses. The addition of sugar is not necessary to retain flavor and quality. The uses of coconut packed in sugar are somewhat more limited than are those of the coconut packed plain. In using the sweetened coconut make corrections for the amount of sugar present in the coconut used.

Packing in sugar sirup or in the water from the center of the nut is not satisfactory because the coconut loses texture and acquires off-flavors. In packaging grated coconut for freezing, press it down and pack it tightly. Compared to fruits it contains little water and so does not expand much in freezing. With a tight pack there is usually still enough air entrapped to allow for any expansion which may occur.

Serving: Because of the low moisture content and the small pieces, grated coconut thaws very quickly and usually can be broken apart and used as soon as it is removed from the freezer.

Frozen grated or shredded coconut can be used in any way in which freshly prepared coconut is used. The texture and structure of the coconut are practically unchanged by freezing and thawing. It can also be used in recipes designed for dry coconut, but corrections for the additional moisture in the frozen product may be needed.

Frozen coconut can be kept in freezer-storage satisfactorily for a year and longer.

COCONUT MERINGUE PIE

YIELD: 6 servings

$\frac{3}{4}$ cup sugar	1 teaspoon vanilla
$\frac{1}{2}$ cup flour	$\frac{1}{2}$ cup frozen grated coconut,
$\frac{1}{8}$ teaspoon salt	slightly defrosted
2 cups milk	4 to 6 tablespoons sugar
2 or 3 eggs, separated	1 baked pie shell

Mix the dry ingredients. Add the milk gradually. Cook the mixture for 15 minutes in a double boiler, stirring constantly until it thickens. Add

⁵ See pages 25 and 26, and 28 of Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*, for illustration and description of coconut grater and method of treating coconut to remove meat from shell.

some of the hot mixture to the slightly beaten egg yolks, stir into the milk mixture, and cook for 3 minutes longer. Cool and add the flavoring and the coconut. Pour the mixture into a baked pie shell and cover with meringue made by beating the egg whites stiff and adding the sugar gradually. Sprinkle with more frozen grated coconut. Bake at 300° F. until the top is delicately brown.

Note: The pastry and filling may be frozen. Since meringue does not freeze satisfactorily, add meringue to frozen pie just before baking and bake at 300° F. until the top is a delicate brown.

COCONUT LAYER COOKIES

YIELD: 2 dozen cookies

½ cup butter, margarine, or hydrogenated fat	¼ teaspoon baking powder
1 cup flour	½ teaspoon salt
1½ cups brown sugar	1 cup finely chopped nuts
2 eggs	1 cup frozen coconut, slightly defrosted
2 tablespoons flour	1 teaspoon vanilla

Work the fat into the flour until smooth. Pat into a thin layer in the bottom of a 9x12-inch pan. Bake at 375° F. until a delicate brown, 10 to 12 minutes.

Top with coconut mixture made by combining the sugar and eggs, adding the flour, baking powder, and salt sifted together, and then the nuts, coconut, and vanilla. Bake at 375° F. about 20 minutes.

Cool cookies, spread them with the following icing, and cut in squares.

2 tablespoons butter or margarine	1 tablespoon lemon juice
1½ cups confectioners' sugar	2 tablespoons orange juice

Note: These cookies may be made with fresh coconut and frozen.

COCONUT UPSIDE DOWN CAKE

YIELD: 8 servings

Coconut mixture:

½ cup butter, margarine, or hydrogenated fat	1½ cups frozen grated coconut, slightly defrosted
1 cup brown sugar	

Melt the fat and sugar together in the bottom of an 8x8x2-inch cake pan. Sprinkle the coconut over the fat and sugar mixture.

Cake batter:

¼ cup shortening	2 teaspoons baking powder
¾ cup sugar	¼ teaspoon salt
1 egg	½ cup milk
1¼ cups sifted flour	½ teaspoon vanilla

Cream the shortening and add the sugar gradually. Add the egg and beat well. Sift the dry ingredients together and add them alternately with the milk, starting and ending with the flour. Add vanilla. Pour the batter over the coconut mixture. Bake at 350° F. until done (about 40 minutes).

COCONUT TOPPING FOR CAKES

½ cup butter or margarine
½ cup brown sugar

YIELD: sufficient for one 9x12-inch sheet cake

½ cup cream or top milk
2 cups frozen grated coconut,
slightly defrosted

Heat together fat, sugar, and cream until the sugar is dissolved. Add the coconut and spread on a sheet cake. Place the cake under the broiler until the top is light brown.

For further recipes using coconut, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

GUAVAS

Guavas may be frozen successfully in several forms. Raw puree prepared from the pulp and seeds, from the shells, or from both combined, and halved or sliced shells retain the fresh guava flavor. Since it is easier to freeze than to can the cooked products, cooked puree, guava sauce, and guava juice may also be successfully frozen.

Only large, ripe, tender guavas should be used for frozen guava shells or slices. Ripe guavas make the best puree. Only the pulp from the seedy portion is recommended for freezing. It has a better color and less stone cells than that made from the shells or the whole guavas. Ripe and half-ripe guavas that are undesirable for frozen products may be used for cooked products such as puree, juice, and jams.

Whole guavas frozen do not make a desirable product.

RAW GUAVA PUREE

1. From seeds and pulp. Remove the seedy portion from cut halves of ripe guavas with a spoon and put it through a strainer to remove seeds.

2. From whole guavas. Cut or mash ripe guavas and put them through a sieve or strainer to produce a puree.

For either product add 1 part of sugar to 4 or 5 parts of puree according to sweetness desired. Mix thoroughly, package, and freeze.

Puree from the pulp and seeds has a smoother texture and better color than that made from whole guavas or from the shells.

RAW GUAVA SHELLS

Use only large, ripe, tender guavas. These may be frozen as halves or slices for salads or desserts. The pared shells produce a less grainy and more desirable product than unpared. Combine 1 part sugar to 4 parts guava shells, package, and freeze. Or, use a 35 percent sugar sirup to cover the shells in the package. The latter seems to produce a better-textured product.

COOKED GUAVA SAUCE

Use large, ripe guavas. Slice the shells in $\frac{1}{4}$ -inch slices and cook until just tender in a 40 or 50 percent sugar sirup depending upon the sugar content of the guavas and the sweetness you prefer. Just before the shells are done, add $\frac{1}{16}$ of a teaspoon of salt per pint of shells. Remove from heat, cool, and pour the sauce into cartons, cover with sirup in which shells were cooked, close cartons, and freeze. If desired, $\frac{1}{4}$ to $\frac{1}{2}$ teaspoon fresh ginger juice, or $\frac{1}{2}$ teaspoon lemon juice, may be added to the cooked sauce before freezing.

COOKED GUAVA JUICE

Prepare juice as for jelly or see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*, for directions. Juice may be frozen unsweetened or sweetened. Sweetened is the method usually preferred. Sugar added in the proportion of 1 part of sugar to 8 parts of juice has given the most acceptable product when the juice is to be used as such. A sweeter product using 1 part of sugar to 4 parts of juice may be desired for certain combinations.

Thaw guava puree and juice only sufficiently to break apart and use as you would fresh puree. In using sweetened frozen guava juice or puree in recipes calling for fresh fruit, decrease the sugar by $\frac{1}{4}$ cup for each cup of frozen fruit mixture used. Thaw guava shells only sufficiently to combine with other ingredients in the recipe.

GUAVA MILK SHAKE

YIELD: 1 serving

1 cup fresh, diluted evaporated, or reconstituted dried whole milk
4 tablespoons sweetened frozen guava juice or guava puree, slightly defrosted.

Combine ingredients and serve.

GUAVA MILK SHERBET

YIELD: 1 quart

1 $\frac{1}{2}$ cups frozen sweetened guava puree, slightly defrosted	1 $\frac{1}{2}$ cups milk
3 tablespoons lemon juice	$\frac{2}{3}$ cup sugar

Dissolve the sugar in the milk and add the fruit mixture gradually, stirring constantly. Freeze the mixture in an ice cream freezer, or freeze in refrigerator, stirring every half hour.

GUAVA VELVA FRUIT. See page 44.

For other ways of using guavas see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

LITCHIS

Litchis of the Kwai Mi, Hak Ip, No Mai Tzse, and Brewster varieties have been frozen satisfactorily. Other varieties have not yet been tested. Choose fully ripe, preferably tree-ripened, fruit. About $1\frac{1}{4}$ pounds of litchis with shells and stems are necessary for 1 pint of frozen fruit.

Litchis may be frozen whole in the shell. Fruits removed from the shell and frozen whole with the pits seem less satisfactory than when pits are removed.

Litchis are very juicy. The tender, juicy quality is best retained by freezing in the shell. Those which were cut in fourths or sixths yielded almost 30 percent juice. It is recommended that they be cut in halves because they retain their juice better. They may be packed in sirup or dry sugar.

The flavor and color of litchis are well retained during freezing but the flesh frozen with dry sugar or sirup toughens somewhat. This may be because the sugar draws water from the cells. Litchis may be drained and frozen in 35 percent sugar sirup and the litchi juice frozen separately with 1 part sugar to 8 or 10 of juice by weight.

LITCHIS FROZEN IN THE SHELL

Leave about $\frac{1}{4}$ -inch length of stem on the fruit to aid in shelling it and also to insure no break in the protective shell during freezing and storage. Wash the litchis and pack them for freezing. They may be packed dry, in 50 percent sugar sirup, or in 2 percent salt solution (2 teaspoons salt per pint of water).

LITCHI HALVES OR SLICES

Wash litchis and remove shells by first cutting around the stem with a sharp pointed knife. Bitter flavors apparently develop first around the stem end. Pull litchi halves from the seed. They may be packed as halves or each half may be cut in thirds. The litchi halves lose less juice and are more attractive in fruit cocktails and salads.

Place fruit and juice in freezing container and cover with a 50 percent sirup. A heavy sirup is recommended because it will be diluted with the litchi juice present. The juice may be mixed with 50 percent sirup and then poured over the fruit.

The fruit with its juice may also be packed in dry sugar by using 1 part of sugar to 10 parts of fruit and juice. Stir in the sugar and allow the mixture to stand until most of the sugar is dissolved. Package and freeze.

Properly frozen litchis can be kept in freezer storage for 1 year or longer with no appreciable loss in flavor; slight toughening may occur.

Serving: Litchis in the shell may be served in the shell as a fresh fruit.

They may also be shelled, halved, and the seed removed and the halves used as fresh fruit in fruit cocktails or in salads. Pieces frozen in sirup or sugar may be used as a dessert sauce, in fruit cocktails, or in salads.

LITCHI, PAPAYA, AND PINEAPPLE SALAD

YIELD: 6 servings

1 pint frozen litchis, slightly defrosted $\frac{1}{3}$ cup mayonnaise
1 quart frozen diced pineapple and 2 teaspoons lemon juice
papaya, slightly defrosted

Combine the fruit and add the lemon juice. Add the mayonnaise, mix, and serve on lettuce leaves.

For other ways of using litchis see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

MANGOES

Ripe mangoes may be frozen as cheeks or slices with sugar or sirup. Puree of ripe mango, utilizing the portion around the seed that cannot be used for slices, makes an excellent product for use in ice cream and other desserts or for use as a sauce.

Further experiments must be made to determine the varieties best suited for freezing, but to date our work indicates that any fruit that is of fine quality in the fresh state will make a good frozen product. In general, the character of the ripe mango is not changed by freezer storage. If the flesh of the fruit has a smooth, slippery quality, it has that texture after freezing. If the flesh is coarse and stringy, it is still coarse and stringy after freezer storage.

Most people have strong individual preferences for different varieties of mangoes and until much more work is done, it will not be possible to state which varieties yield frozen products that are acceptable to the greatest number of people.

Green mangoes of any variety that make satisfactory products for immediate use may also be used for freezing. Freezing the cooked sauce is more efficient and less time-consuming than canning it. The enzymes have been inactivated, and the sugar can be well blended with the fruit.

The ascorbic acid in green mangoes is unusually stable. No appreciable amount is lost during cooking by any of the recommended methods, in pureeing, chilling, freezer storage, or in thawing.

Ripe Mangoes

Select mangoes that are fully ripe but firm. If it is necessary to complete the ripening process after they are picked, cover them and place them in a relatively cool, dark place.

The initial color of the mangoes, ranging from a pale yellow to a deep orange, is well retained in each variety during freezer storage, regardless

of the method of packing. Color stability is evidenced by its retention even in fruit allowed to stand exposed to the air after thawing.

Mangoes frozen without added sugar or sugar sirup acquire off-flavors. If the outer portions contain green strings, they also tend to acquire off-flavors even when frozen in sugar or sirup.

Preparation: Wash the mangoes and pare them, cutting deep enough to remove all tough portions, or peel by pulling thick skin from the flesh. Discard a slice of the stem end because it is usually more fibrous and less ripe, and may acquire an off-flavor. Cut off the cheeks of each mango, leave whole or cut them into the desired shape and size. Do not slice off the flesh near the seed as in most varieties it is quite fibrous. Scrape the flesh from the seed and combine with small and odd-shaped pieces to make puree. Use a saw-toothed knife for scraping.

Ripe mangoes may be packed with either dry sugar or sugar sirup. Mangoes vary greatly in their natural sugar content and the amount of sugar or the concentration of the sirup to be used for freezing must be varied.

For the dry sugar pack, place the mangoes in a shallow bowl, sprinkle with sugar in the proportion of 1 part sugar to 8 to 10 parts fruit by weight according to sweetness of fruit and individual taste. Work with only a few mangoes at a time. Allow them to stand a few minutes until the sugar is dissolved. Mix them gently and transfer them to the package. With very juicy mangoes, there may be enough juice present to cover the pieces.

Mangoes packed in sirup have more liquid than those packed in dry sugar. Usually a 35 percent sirup is most satisfactory. Place the sirup in the carton and slice the mangoes directly into it.

Frozen mango cheeks or slices are best as fresh sauce but they also make excellent pie, cobbler, and upside down cake. They may also be used to make jam and butter if desired.

Ripe mangoes may be made into a sauce and then frozen. Make the sauce as you would green mango sauce (p. 35), using only sufficient sugar to sweeten. Add 1 tablespoon of lemon juice to each pint of sauce, if desired. A second method of making mango sauce, in which the shape of the slices is retained, is to add the mangoes to a boiling sirup (1 cup sugar to 2 cups of water) and cook them 10 to 15 minutes until the edges become transparent. One tablespoon of lemon juice per pint may be added if desired.

RIPE MANGO PUREE

Puree may be made from whole mangoes, the fibrous portions pared off after removing the thick skin, the more fibrous side pieces, and the

pulp that has been scraped from the seeds. No difference in quality of purees made from the different portions was observed. Add sugar in the proportion of 1 part dry sugar to 8 or 10 parts of fruit by weight, and package. One cup of puree weighs slightly more than $\frac{1}{2}$ pound. One-half teaspoon of ascorbic acid per quart of fruit may be added. Citric acid may be added if a tart flavor is desired, using $\frac{1}{4}$ teaspoon per quart of puree.

MANGO CRISP

YIELD: 6 servings

- | | |
|--|---------------------------------------|
| 1 tablespoon lemon juice | $\frac{1}{2}$ cup flour |
| 2 cups frozen ripe mangoes, slightly defrosted | $\frac{1}{8}$ teaspoon salt |
| | $\frac{1}{4}$ cup butter or margarine |

Mix the lemon juice with the mangoes and spread them in a shallow baking dish. Mix the dry ingredients and cream them with the fat. Sprinkle the mixture over the mangoes. Bake at 375° F. for 30 minutes.

MANGO MILK SHERBET

YIELD: 2 quarts

- | | |
|--|---|
| 1 to 1½ cups sugar | $\frac{1}{3}$ cup lemon juice |
| $\frac{3}{4}$ cup water | 3 cups fresh, diluted evaporated, or reconstituted dry milk |
| 3 cups frozen ripe mango puree, slightly defrosted | |

Bring the sugar and water to the boiling point. Cool the sirup and add the mangoes and lemon juice. Add this mixture slowly to the milk, stirring constantly. Freeze in an ice cream freezer.

RIPE MANGO VELVA FRUIT. See page 44.

Green Mangoes

Wash the mangoes and pare them. Cut thin slices from each cheek of the fruit and then from the sides; thin slices require a shorter cooking time than do thick slices. The sauce may be cooked in a heavy saucepan on top of the stove, in a pressure saucepan, or in a casserole in the oven.

Always add sugar to the sauce, varying the quantity according to the ripeness and the tartness of the mangoes. Otherwise it tends to develop a bitter taste during freezer storage and thawing. The sauce should always be pureed before freezing because any fibrous portions that are left are very stringy. The sauce tends to acquire a jelly-like consistency upon standing, so package it as soon as it is cool.

Frozen green mango sauce may be used in the same ways as fresh mango sauce. It is excellent served as a dessert sauce, breakfast fruit, as a sauce on puddings, in sherbets or ice creams, or with meat.

SAUCEPAN METHOD

- | | |
|---------------------------------|-------------------------|
| 4 cups mango slices (1½ pounds) | $\frac{1}{2}$ cup sugar |
| 1½ cups water | |

Place the mangoes and water in a heavy saucepan; the lower part of the pressure saucepan with an ordinary lid does very well. The amount of stirring necessary to prevent burning is minimized by using a heavy-bottomed pan. Mango sauce spatters during cooking; therefore a large pan is more satisfactory than a small one.

Cook the mango slices in the water until they are tender, about 15 minutes. Stir in the sugar and bring the mixture to a full boil. Puree the sauce. Chill the sauce quickly, package, and freeze.

The waste in pureeing is slight, less than 0.5 percent, and consists chiefly of the hairy residue from near the seeds and coarse strings near the outside of the fruit. Sauce which is pureed before the sugar is added tends to be thinner and more watery than that pureed after the sugar has been added. It also requires more handling.

PRESSURE SAUCEPAN METHOD

$\frac{1}{2}$ cup water	$\frac{1}{2}$ cup sugar
4 cups mango slices (1½ pounds)	

Pour water in pressure saucepan. Place mango slices on top of rack. Adjust cover. Allow steam to escape, which requires about 5 minutes. Place the weight over vent and allow pressure to reach 15 pounds, which requires about 2 minutes. Allow pressure to remain at 15 pounds for 3 minutes. Bring the pressure down following the directions which come with your pressure saucepan. Remove rack and stir the sugar into the cooked mangoes. Return cooker to the stove and bring sauce to a full rolling boil. Puree, chill, package, and freeze.

OVEN METHOD

4 cups mango slices (1½ pounds)	$\frac{1}{2}$ cup sugar
$\frac{1}{2}$ cup water	

Place mangoes and water in a casserole and cover. Bake in a 375° F. oven until the mangoes are tender (1 to 1½ hours). Stir in the sugar and return the dish to the oven until the mixture returns to the boil. Puree and transfer the sauce to a container in which it will cool quickly; chill, package, and freeze.

GREEN MANGO PIE*

YIELD: 6 servings

3 cups pared mango slices	1 to 2 tablespoons flour if mangoes
1 to 1½ cups sugar	are juicy
1 to 2 tablespoons water	2 tablespoons butter or margarine

Line a pie pan with pastry. The pan may be a paper pie plate with metal rim, a pyrex, aluminum, or enamel pie plate. Put a layer of mango slices in the pastry shell, sprinkle with lemon juice, then with sugar and

* See pages 19 and 20 for general directions for frozen pies.

flour, dot with fat and cover with another layer of fruit, sprinkle with lemon juice, then with sugar and flour, and dot with fat. Cover with pastry, sealing the upper and lower crusts together well. Do not cut any openings in the upper crust. Place in freezer overnight. Wrap in cellophane, seal, and insert in stockinette. Return to the freezer.

Serving: Remove pie from freezer, take from wrappings, and place it in the solidly frozen state in a 450° F. oven. As soon as the upper crust is thawed (about 5 minutes), cut slits in it to permit the escape of steam during baking. At the end of 15 minutes, lower the oven temperature to 375° F. and continue baking until the crust is a delicate brown and the mangoes are tender (about 40 minutes).

DEEP DISH GREEN MANGO PIE

Make this pie according to the directions given above except use a deeper dish (about 1½ inches) and omit the lower pastry crust. This method avoids any danger of an underdone, juice-soaked lower crust. Do not use a paper dish because the fruit juice tends to soak into it.

GREEN MANGO VELVA FRUIT. See page 44, table 2.

For other uses of mangoes, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

MULBERRIES

Select ripe fruit. Wash in running cold water or water containing ice. Clean, and discard any underripe and overripe berries. Pack with dry sugar in the proportion of 1 part sugar to 5 parts fruit by weight, or in 40 percent sirup.

Frozen mulberries may be used as sauce. Those packed in sugar make excellent pies. They can also be used in sherbets and beverages.

MULBERRY PIE

YIELD: 6 servings

2 cups frozen mulberries,
slightly defrosted
½ to ¾ cup sugar
⅛ teaspoon salt

2 tablespoons flour or quick-cooking
tapioca
1 tablespoon butter or margarine

Drain juice from the fruit and mix it with the dry ingredients. Place the berries in the lower crust and pour the juice over them. Dot with fat. Put on top crust or lattice strips, and bake in a 450° F. oven for from 10 to 15 minutes, then at 375° F. until the crust is a golden brown (about 30 minutes).

For additional recipes using mulberries, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

PAPAYAS

Papaya for freezing should be of high initial quality as freezing does not improve the flavor. To obtain good quality papaya, the fruit should not be picked until it shows the first signs of yellow color. It should then be allowed to ripen in a place where it will not be exposed to direct sunlight.

There is no justification for picking papaya for local consumption when it is still in the green stage to prevent it from being attacked by fruit flies, because the flies rarely sting the papaya until it is almost fully ripe.

Experiments have shown that the sugars develop rapidly during the last few days of ripening and that flavor is associated with sugar content. Papayas picked in the green stage and then allowed to color up are apt to be flat and tasteless. The papaya is a delicate fruit and should not be handled as if it were a coconut.

Solo papaya has proved to be a difficult fruit to freeze satisfactorily. If the fruit is not fully ripe the flavor is poor; when fully ripe, slices, cubes, and chunks tend to soften when frozen and do not retain their shape well. Pieces frozen in pectin or gelatin salads and in mixed fruit cocktails containing pineapple are very acceptable. To date, puree has proved to be the most satisfactory frozen product.

Papayas contain many different enzymes, the best known of which is papain. Although ripe papaya is said to contain little or no papain, the bitter flavor which often develops when papaya is combined with protein foods such as milk and eggs may be related to its enzyme content.

Steaming prior to freezing to inactivate the enzymes has not proven satisfactory in retaining the shape, texture, or flavor. Papaya has an exotic taste and aroma which are easily affected.

Cooking plain papaya bleaches the orange color and changes the flavor. Cooking in sugar sirup, or in sugar sirup containing citric acid, firms the outer layers of the pieces somewhat. The results were not completely satisfactory nor was steaming to inactivate the enzymes.

Pieces of papaya soaked in calcium chloride of several concentrations and for several periods of time prior to freezing have not been satisfactory. The texture was poor and the flavor unacceptable. A calcium lactate dip proved more satisfactory but the results have not justified its use as the improvement in texture was slight. (A calcium dip is sometimes used in firming whole tomatoes prior to canning; a calcium pectate with jellying properties is formed.)

Preparation: Select papayas which are fully ripe but firm, and chill them. Wash and cut them in half lengthwise. Remove the seeds and fibrous material clinging to the inside of the papaya.

The papaya slices soften less if frozen in an acid fruit juice, such as pineapple to which sugar has been added, than if frozen alone or with dry sugar. Ripe papayas cut in slices or cubes before freezing, and packaged with or without dry sugar, resemble a puree after thawing.

BALLS OR CUBES

Cut the papaya flesh from the chilled fruit using a ball cutter, or cut the papaya flesh in cubes. Discard any green portions. Freeze the pieces with other fruit containing acid, such as pineapple with added sugar, for use as a fruit cocktail. Since papaya softens during freezer storage and thawing, it may be frozen and served in individual containers. Some of the plastic covered dishes lend themselves to this use.

PUREE

After removing the seeds, scoop out the pulp from the skin. Put the pulp through a Foley food mill or a rotary pureer. No appreciable loss of ascorbic acid occurs during either method of pureeing. Add sugar in the proportion of 1 part to 10 parts of fruit and $\frac{1}{4}$ teaspoon of citric acid per pint of puree.

Papaya puree makes an excellent medium for freezing other fruits, particularly pineapple cubes.

Papaya contains appreciable amounts of pectin or other jellying substances. Thawed purees allowed to stand usually thicken and a clear liquid separates. The latter forms a firm gel.

Frozen papaya puree has been successfully used in Papaya Milk Sherbet, Papaya-Pineapple Nectar, other papaya drinks, and in products in which fresh papaya pulp may be used. Reduce the sugar in the recipe 1 to 2 tablespoons for each cup of frozen papaya puree used. In some recipes it may be desirable to reduce the lemon or lime juice because of the citric acid that has been used in the frozen puree.

PAPAYA VELVA FRUIT. See page 44, table 2.

See Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*, for other ways to use papaya.

PASSION FRUIT

Passion fruit may be frozen satisfactorily as a juicy pulp.

Wash the fruit and cut it in half. Remove the pulp and seeds with a spoon. Press the juice through a poi cloth or through several thicknesses of cheesecloth. Add sugar in the proportion of 1 part sugar to 5 parts pulp by weight. Package and freeze.

The frozen passion fruit juice may be used in fruit punches, sherbets, ice creams, and cake icing.

For recipes using passion fruit, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*. Reduce the sugar as needed.

PINEAPPLE

Pineapple of the Smooth Cayenne variety makes an excellent frozen product. It is essential for the best flavor, however, that it be ripened on the plant. There is no starch in the fruit to change to sugar after picking. Pineapples, unlike some light-colored fruits, do not darken oxidatively.

Preparation: Choose ripe fruits of the summer season. Pare the fruit, remove the eyes and the core. Cut the fruit in wedges, cubes, or sticks, or crush it. Slices cut thin, about $\frac{1}{4}$ inch, either crosswise or lengthwise, may also be frozen satisfactorily. Cover with a 40 percent sirup or, if the fruit is very sweet, use a 30 to 35 percent sirup. Pineapple may also be packed in its own juice with or without added sugar or in 1 part sugar to 6 parts fruit by weight. Some workers have reported that off-flavors sometimes develop in dry sugar packs.

Odd-shaped or broken pieces may be cut small to make "crushed" pineapple, and packed with 1 part sugar to 6 or 8 parts of pineapple by weight, depending upon the sweetness of the fruit.

Small cubes of pineapple added to papaya puree or to cut up papaya and then frozen make a particularly nice breakfast fruit or dessert.

PINEAPPLE JUICE

Cut a pared ripe pineapple into eight or more pieces and squeeze through one thickness of poi cloth or sugar sack. It has been found that juice from sweet summer season Smooth Cayenne pineapples produces a fine frozen product without the addition of sugar. Less sweet pineapple may require as much as 1 cup sugar to 10 cups of juice. Freeze the juice promptly after extraction.

The sweetened pineapple juice makes a good medium in which to freeze other fruits such as papaya.

The flavor of fresh ripe pineapple is best obtained if the frozen product is served while it still contains a few ice crystals. If thawed and allowed to stand for some time before serving it may taste more like canned pineapple than fresh.

Frozen pineapple wedges or other shapes can be served as would the fresh fruit, and in fruit cocktail, salads, pie, and upside down cake.

The frozen crushed pineapple can be used in sherbets, in salads, and as a sauce or topping on ice creams or puddings. A layer of slightly thawed crushed pineapple may be added just under the crust of mince pie before baking.

The frozen sweetened pineapple juice can be used in the same way as fresh juice, that is, alone as a drink or mixed with other fruit juices.

Because of the presence of the proteolytic enzyme bromelin, raw pineapple, either frozen or unfrozen, cannot be used satisfactorily in gelatin

desserts. It causes liquefaction of the gelatin. If the pineapple is cooked for about 3 minutes it can be successfully used with gelatin.

PINEAPPLE PIE

YIELD: 6 servings

This pie may be made from frozen, slightly thawed fruit, or pies prepared from fresh pineapple may be frozen. (See Green Mango Pie, p. 36.)

½ cup sugar	1 tablespoon butter or margarine
2 to 3 tablespoons flour	1 recipe pastry
1½ cups diced pineapple	

Mix sugar and flour. Line pie tin with pastry. Add a layer of fruit. Sprinkle sugar mixture over the fruit. Continue doing this until all the fruit has been used. Dot with fat. Cover with top crust and seal the edges. Bake at 450° F. for 10 minutes. Reduce heat to 350° F. and continue baking until the crust is a golden brown, about 30 minutes.

Variation: A whole egg may be added to the above recipe. Mix the flour and sugar together and add the beaten egg; add to the pineapple. Mix well and pour into pastry-lined pie pan and proceed as above. If winter pineapple is used, it may be necessary to increase the sugar to $\frac{3}{8}$ or $\frac{3}{4}$ cup.

PLUMS

The red Methley plum is available in some sections of the Hawaiian Islands.

Select fully ripe but firm fruit which has been tree ripened. Wash in water containing ice or in cold running water; cut in half and remove pits. Pack the fruit in halves or in quarters. The plums may be peeled, if desired.

Pack the fruit in either dry sugar or in sirup. Plums packed in dry sugar have a better flavor but the skins are somewhat tougher than are those packed in sirup. If dry sugar is used, 3 parts plums to 1 part sugar is the best proportion for the less sweet plums and an 8 to 1 proportion for sweet plums. Mix the sugar in well to make sufficient sirup to cover the fruit. If sirup is used, it should be about 50 percent sirup for less sweet plums and 35 percent for sweet plums. It should be well mixed with the plums and be sufficient to cover the fruit.

Frozen plums with the peeling left on should not be stored more than 5 or 6 months because of the tendency of the skins to take on a hay-like oxidized flavor. Frozen plums make excellent pies and the high sugar content is not objectionable; in fact, it is usually necessary to add more sugar to them for use in pies.

Plum puree is an excellent frozen product. It can be served as a sauce, in fruit ice cream, or in fruit ice. After pureeing the fruit, mix it well with sugar in the proportion of 1 part sugar to 3 to 5 parts of fruit by weight. Pack and freeze.

PLUM PIE

YIELD: 6 servings

2 cups partially defrosted plums
packed in sirup $\frac{1}{8}$ teaspoon saltAbout $\frac{1}{4}$ cup sugar1 to 2 tablespoons butter or
margarine

1 tablespoon flour

Drain plums. Mix dry ingredients well and add them to the juice from the plums; mix well and pour over the drained plums. Pour fruit mixture into pie shell and dot with fat. Cover with upper crust, and bake in a 450° F. oven for from 10 to 15 minutes, then at 350° F. for about 30 minutes longer.

PLUM COBBLER

YIELD: 6 servings

About $\frac{1}{3}$ cup sugar $\frac{1}{4}$ teaspoon cinnamon

2 tablespoons flour

2 cups partially defrosted plums
packed in sirup $\frac{1}{4}$ teaspoon nutmeg

1 tablespoon butter or margarine

Make a baking powder biscuit or shortcake dough using $1\frac{1}{2}$ cups of flour or $1\frac{1}{2}$ cups prepared biscuit mix.

Mix the sugar, flour, and spices and blend them with the juice drained from the plums. Pour over the plums. Spread the mixture in a greased baking dish and dot with fat. Place the cobbler dough on top. Bake at 400° to 450° F. for 30 to 40 minutes.

Serve hot, plain or with cream or custard sauce.

SOURSOP

Soursop, which is not used in the cooked state, is one of the fruits that freezes well and retains its fresh and characteristic flavor after freezer storage.

Preparation: Select soft ripe fruit. Peel and cut lengthwise through the center. Discard the core which has a granular texture and little flavor. Separate the seeds, which are embedded in pockets in the white flesh, and discard them. Puree the pulp and add sugar to it in the proportion of 1 part sugar to 6 parts fruit pulp by weight.

If desired, add about $\frac{1}{4}$ teaspoon ascorbic acid to each quart of puree. The puree, which has the thickness and consistency of a medium white sauce, is a cross between a juice and a puree. It is excellent in beverages, sherbets, and ice creams. The flavor blends well with that of bananas and pineapple.

Frozen pieces of the pulp are not successful because of the coarse texture.

Serving: Substitute slightly thawed soursop puree in sherbet and beverage recipes calling for fresh soursop. Correct the recipe for the sugar present in the frozen puree by decreasing the sugar by 2 tablespoons for each cup of puree used.

For recipes using soursop, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

STRAWBERRIES

Excellent strawberries are grown at the higher elevations in Hawaii, but there has been no opportunity to conduct experiments with the varieties grown in the Islands. The directions given here are based on experimental work done on the Mainland. Because strawberries are an important fruit used for commercial freezing, much work has been done to develop varieties especially suitable for freezer storage. Not all varieties of strawberries make a satisfactory frozen product.

Selection: Freeze only bright red, firm, ripe berries of good flavor. Berries which are red all the way through make a more attractive product. Avoid green, mushy, and overripe fruit. Strawberries lose quality rapidly, so freeze them quickly. From $1\frac{1}{2}$ to 2 quarts of berries are required for 1 quart of frozen fruit.

Preparation: Wash only a few berries at a time in ice water. Lift them out of the water, drain, and hull them. Strawberries for freezing may be crushed, sliced in pieces about $\frac{1}{4}$ inch thick, or in halves. Place slices, halves, or crushed berries in small amounts in a shallow dish and sprinkle sugar over them in the proportion of 1 part sugar to 4 or 5 parts of fruit by weight. Mix gently until some of the sugar is dissolved, pack, and freeze.

For puree, press the berries through a food mill or a sieve. Add 1 pound (2 cups) of sugar to 4 or 5 pounds of fruit.

In any of the strawberry packs, ascorbic acid may be added in the proportion of $\frac{1}{4}$ teaspoon per quart of fruit.

SURINAM CHERRIES

This bright red fruit retains the color well during freezing and storage. Since the cherries seem to develop a bitter taste on standing, they should be prepared, packaged, and frozen quickly.

Preparation: Select ripe, freshly picked cherries. Wash in water containing ice or in running cold water, discarding any partially green ones or any that have begun to spoil. Remove stems and blossom ends. Remove seed with tip of knife or with a pitter. Cut fruit in halves or quarters. Pack in 50 percent sirup.

If small quantities are wanted for combination with other fruits, freeze in small units or in blocks in an ice-cube tray and treat as recommended for banana cubes. (See page 24.)

Serving: The Surinam cherry is very acid, and has a distinct, almost acrid, flavor. It is best used with other fruits; it adds accent in both color

and taste. A few pieces added to each serving of fruit cocktail or molded, gelatin salad give piquancy.

For recipes using Surinam cherries, see Hawaii Agricultural Experiment Station Bulletin 96, *Fruits of Hawaii*.

VELVA FRUIT¹

Fresh or frozen fruit purees may be used for making Velva Fruit. Unsweetened or sweetened frozen purees are satisfactory. If sugar has been added to the puree before freezing, the puree will defrost more rapidly and smoothly than unsweetened puree. The sugar reduces the melting point and also prevents formation of large ice crystals which are hard to defrost.

When using frozen sweetened puree (6 cups crushed fruit with $1\frac{1}{2}$ to 2 cups sugar—that is, 1 part sugar to 3 or 4 parts fruit) to make Velva Fruit, remove puree from freezer. Put sealed container in cold or lukewarm (never hot) water to speed thawing. A quart of puree will thaw in about 2 hours. When puree reaches room temperature, combine with other ingredients given in table 2, and follow the general directions for mixing.

For best results the formula for this dessert must be varied slightly for different fruits, depending on their sugar content and degree of maturity. Tart fruits such as berries, plums, guavas, and green mangoes will require little or no addition of lemon juice. Less tart fruits, such as papayas and ripe mangoes, require a slightly different formula. Less sugar is required, and lemon juice is added.

Note: The amount of sugar given in table 2 is for unsweetened fresh or frozen puree. If frozen sweetened puree is used, omit the sugar or use a smaller amount as required to suit the individual taste.

TABLE 2. General Formula for Velva Fruit. Yield: 3 to 4 quarts.

Fruit Types	Pureed Fruit	Sugar	Gelatin	Water	Lemon Juice	Salt
	<i>cups</i>	<i>cups</i>	<i>tablespoons</i>	<i>cups</i>		<i>teaspoons</i>
Tart fruits: Berries, plums, guavas, green mangoes	6	2	2	$\frac{1}{2}$	None to 2 tablespoons	$\frac{1}{2}$
Less tart fruits: Papayas, ripe mangoes	6	$1\frac{1}{2}$	2	$\frac{1}{2}$	$\frac{1}{4}$ cup, or less if desired	$\frac{1}{2}$

Mix together the fruit puree, sugar, salt, and lemon juice, if used.¹ Keep puree mix cool and avoid excessive mixing in order to preserve the ascorbic acid. Soften gelatin in the cold water for 5 minutes. Dissolve

¹ Based on directions given in: *Making Velva Fruit at Home*. AIE-22. U. S. Dept. Agr. 1945.

thoroughly by heating to 180° F. over boiling water (for about 10 minutes), add dissolved gelatin to fruit-sugar mixture stirring to prevent formation of stringy lumps of gelatin. Freeze the mixture as an ice cream or sherbet in a hand-turned freezer, using 1 part salt to 8 parts of ice.

Use at once, or place in suitable containers, label, and store in home freezer.

Note: Storage for longer than 3 months is not recommended as the Velva Fruit gradually loses flavor.

Velva Fruit may be frozen in a mechanical refrigerator but the volume will be less and the product less smooth than when frozen in an ice cream freezer. Follow the directions for your refrigerator. Put the fruit mixture in the freezing pans and freeze until firm. Turn into a chilled bowl and beat with hand or electric beater. Work quickly so mixture does not completely melt. Return to trays to harden if to be used at once, or place in cartons and store in home freezer.

MIXED TROPICAL FRUITS

Mixed tropical fruits are among the most distinctive and pleasing of the Hawaiian frozen fruit products.

Preparation: Select fresh, high-quality, ripe fruits. Prepare as directed for each individual fruit. Pack in container and cover with from 35 to 50 percent chilled sirup.

Frozen mixed fruits may be used as cocktails or in salads. Any left-over juice is excellent in sherbets or iced drinks. Usually the addition of lemon juice, or some other acid fruit, is advisable in making iced drinks or sherbets.

Suggested combinations that yield 6 to 8 servings for fruit cocktail or fruit salad are:

1. 1½ cups pineapple chunks
1½ cups papaya cubes or balls
½ cup Surinam cherry halves
2. 1½ cups pineapple chunks
1½ cups strawberry slices
3. 1½ cups pineapple chunks
1½ cups papaya cubes or balls
1 cup guava slices
½ cup Surinam cherry halves
4. 1½ cups pineapple chunks
1 cup papaya cubes or balls
1 cup litchi halves

Cubes of Cavendish and Bluefield bananas were tried in each of the above recipes but were not satisfactory. They acquired an undesirable soft texture and tended to discolor, particularly in the upper portion of

the carton. Some acquired an off-flavor. The banana flavor was absorbed by some of the fruits. This was most noticeable in the pineapple and papaya, in both of which the banana flavor dominated.

FROZEN TROPICAL JELLIED SALADS

Frozen gelatin and pectin salads are excellent mediums for the use of tropical fruits. The gelatin or pectin base protects the fruits from the air. The use of fruit purees, rather than water, in the base gives a more flavorful product and one having more body. The salads must be served as frozen salads, that is, before they are thawed or before the base collapses. The gelatin base tends to collapse and "weep" more readily than does an alkaline-treated low-methoxyl pectin⁸ base.

Both types of salad stand up better if they are frozen in shallow containers. They thaw more uniformly. They can then be cut in squares of suitable size for serving. The salads may also be frozen in small paper or plastic cups for individual servings.

To obtain uniform softening, the salads should be placed in the refrigerator. Since they are to be served as frozen salads, they should be permitted to soften only and NOT DEFROST. This requires $\frac{1}{2}$ to 1 hour.

GELATIN AND FRUIT PUREE BASE

YIELD: 4 to 5 servings

$\frac{1}{2}$ tablespoon gelatin for guava and mango puree OR 2 tablespoons gelatin for papaya puree	1 tablespoon lemon juice
$\frac{1}{4}$ cup cold water	$\frac{1}{4}$ cup sugar
1 cup puree, such as guava, papaya, or mango	$\frac{1}{8}$ teaspoon salt
	$1\frac{1}{2}$ cups diced tropical fruits

Soak the gelatin in cold water for 5 minutes and dissolve it over hot water. Mix the puree, sugar, and salt and add them slowly to the hot gelatin; cool, and add lemon juice. Pour the mixture over $1\frac{1}{2}$ cups of tropical fruits; package and freeze.

Pineapple must be cooked 3 minutes before it is mixed with the gelatin, otherwise the enzymes liquify the gelatin.

PECTIN AND FRUIT PUREE BASE

YIELD: 4 to 5 servings

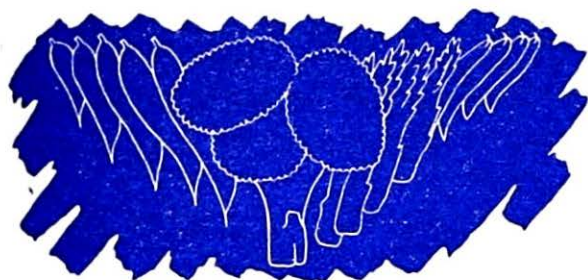
$\frac{1}{3}$ cup water	$\frac{1}{2}$ cup sugar
$\frac{2}{3}$ cup fruit puree	2 teaspoons low-methoxyl pectin
1 tablespoon lemon juice	$1\frac{1}{2}$ cups diced tropical fruits

Mix the pectin with the sugar, add water, and beat until the pectin is dissolved. Add the puree and heat to the boiling point. Pour the mixture over the fruit. Package and freeze.

Fruits that may be used are: pineapples, papayas, guavas, ripe mangoes, litchis, and Surinam cherries.

For suggested combinations, see those listed under frozen Mixed Tropical Fruits (page 45).

⁸ This product is not at present available in retail amounts.



Freezing Vegetables

EQUIPMENT

Most of the equipment for preparing vegetables for freezing is in the average kitchen. Large kettles are necessary for blanching and cold dipping. A large kettle with perforated insert is convenient for water or steam blanching, but a frying basket, a cheesecloth bag, or square of cheesecloth may be used.

SELECTION

For the best results, select vegetables that are perfect for table use. Over-mature vegetables usually become tough in texture and lose flavor when frozen. Slightly immature vegetables may be better than over-mature ones. Selection of high-quality products is most important since freezing will not improve the original quality of the vegetables.

The more intense the color of the vegetable, the better the frozen product will be.

To date only a few vegetables grown in Hawaii have been studied for freezing purposes: asparagus, broccoli, edible-pod (Chinese) peas, green and wax snap beans, lima beans, and soybeans.

Other vegetables that are known from mainland experience to freeze satisfactorily are peas, sweet corn (particularly yellow varieties), cauliflower, chard, greens such as spinach, and a few others. Suitable methods have not been worked out for freezing vegetables of very high water content ordinarily eaten raw, such as cucumbers, radishes, celery, lettuce, and tomatoes. All these become flabby and unattractive when frozen.

Some varieties of vegetables are known to freeze better than others. Sufficient work has not yet been done with vegetables in Hawaii to make specific recommendations regarding the best local varieties for freezing.

PREPARATION

Prepare vegetables immediately after harvesting (1 to 4 hours between garden and freezer). Harvest vegetables early in the morning. Foods picked in the evening and put in the freezer locker the following day will not be so high in quality as those frozen within a few hours after harvesting. Clean vegetables thoroughly and prepare them as for cooking.

Scalding or Blanching

All vegetables *must be scalded or blanched* for a few minutes before being frozen in order to preserve the flavor, texture, color, and food value. Blanching also brightens the color of vegetables and makes them easier to package because they have lost their crispness.

Water blanching: Scald about 1 pound of vegetables in 1 to 2 gallons of boiling water. A wire basket or cheesecloth sack may be used for this. Do not blanch more than 1 pound of green leafy vegetables or 2 pounds of other vegetables at one time. If the heat is insufficient to bring the water back to boiling within 1 minute, then use fewer vegetables.

Count blanching time after the water begins to boil again.

Keep vegetables moving in the water during blanching to prevent matting of leafy vegetables and to obtain more uniform blanching of the other vegetables. If the vegetables are not agitated, those on the bottom of the kettle may be over-blanching while those on top will be insufficiently precooked.

Steam blanching: A 10- or 12-quart kettle with a tight-fitting cover is needed for steam blanching. Put $1\frac{1}{2}$ to 2 quarts of water in the kettle and bring to a boil. You will need a rack to hold the food *above* the water. Place the vegetables—not more than 1 or 2 pounds at one time—in the wire basket, colander, or cheesecloth square and put on the rack when the water is boiling briskly. Cover, and when water boils again and steam forms, start to count time, and steam for period recommended. There should be room for steam to circulate freely around the vegetables. Steam blanching takes about a minute longer than water blanching.

A steam pressure cooker may be used as a blanching kettle, but do *not* clamp down the lid or close the petcock.

Never use steam for blanching leafy vegetables, such as spinach, because of their tendency to mat.

Cooling

This is one of the most important and also one of the most neglected steps in freezing vegetables. Plunge the blanched vegetable immediately into water containing ice or in running cold water. Leave the vegetable there only until it is cooled. Failure to cool the vegetable completely and quickly results in loss of color, flavor, texture, and nutrients during freezer storage. Allowing the blanched vegetable to remain in the chilling water too long results in a water-logged vegetable, and in an excessive loss of water-soluble constituents.

Do *not* allow the vegetables to stand in cooling water beyond the length of time required for cooling. A safe rule is to cool for a time equal to the blanching time.

Test for proper chilling of vegetables, such as asparagus or snap beans,

by breaking or cutting. The vegetable should be chilled to the center.

Remove vegetables from the cooling water and drain. The cooled vegetables may be drained on paper towels or clean dish towels before packaging.

PACKAGING⁹

As soon as the vegetables are chilled and well drained, pack into suitable containers, filling to the top (except spinach, which should be $\frac{1}{2}$ inch from the top to allow for expansion when frozen). Shake the container to insure a full pack. Press as much of the air as possible out of the package because air causes destruction of vitamins and may dry out the vegetable. Heat seal packages with a warm iron or use tight-fitting lids. Too much heat may cause an imperfect seal.

Label the container with date of packing, variety, and kind of food and any special treatment.

FREEZING

Be sure the temperature of your home freezer is 0° F. or lower. Follow these rules to speed freezing:

Don't freeze too many packages at once.

Place packages against freezing plates or coils, spreading them out so air can move between them.

Storage at Low Temperatures

After freezing (24 hours or so), store packages at 0° F. or lower. At temperatures above 0° F. frozen vegetables lose quality rapidly.

To help you know how many and what kinds of frozen foods you have, post a large card with columns for dates and foods near the freezer. List the foods as you put them in and check them off as you take them out. Use them within 9 to 12 months.

COOKING

Most vegetables are cooked from the solidly frozen state. Stem vegetables, such as broccoli and asparagus, are exceptions to this rule. They cook more uniformly if they are thawed sufficiently so they can be broken apart before they are put on to cook. Defrost them slightly in the sealed original package; 1 to 2 hours in the refrigerator, or 15 to 30 minutes at room temperature, is sufficient.

Blocks of frozen leafy vegetables such as spinach, may be cut in $\frac{1}{2}$ -inch squares using a sharp knife and a cutting board. Frozen blocks of snap beans, lima beans, and soybeans may be broken apart by hitting the package sharply several times against a hard surface.

⁹ For further information, see *Home Freezers and Packaging Materials*, Hawaii Agr. Expt. Sta. Cir. 27, 1949.

Cook frozen vegetables in a minimum amount of water so that not more than 1 or 2 tablespoons of water remain at the end of the cooking period. Amounts of cooking water given in the directions printed on the packages of commercially frozen vegetables may be more than you will need. These amounts have purposely been made ample so that there is little possibility of the vegetables boiling dry and burning, even with the most inexperienced of cooks.

The most common fault in cooking frozen vegetables is *overcooking*. The tissues have already been softened by blanching and by freezing and therefore they usually require from one-half to three-fourths the cooking time of the corresponding fresh vegetable.

Boiling

Have the water boiling rapidly when the vegetable is added and bring the water back to the boil as quickly as possible. Then reduce the heat so that the water boils gently the rest of the cooking period. As soon as the water steams briskly, break up any frozen blocks of vegetables with a fork. Count the cooking time as soon as the water returns to the boil. Salt may be added at any time.

Pressure Saucepan

Frozen vegetables may be successfully cooked in a pressure saucepan. However, it is most important to watch the time during cooking because a fraction of a minute too long will *overcook* the vegetable. This results in poor color, flavor, and texture, and possible loss of vitamin content. For uniform cooking, thaw vegetables sufficiently to permit breaking them apart. Have about $\frac{1}{2}$ inch of rapidly boiling water in the bottom of the pan and add the vegetables to it. Follow directions which come with the pressure saucepan. Just before putting the weight on the vent, shake the pan to jar any clumps of vegetables apart. Begin counting the cooking time when the desired pressure is reached. Bring the pressure down quickly to avoid overcooking, and serve the vegetable while it is still very hot.

TABLE 3. Approximate Cooking Times for Frozen Vegetables.

Vegetable	Boiling	Pressure Saucepan	
		5 lbs.	15 lbs.
	<i>Minutes</i>	<i>Minutes</i>	<i>Minutes</i>
Asparagus.....	5 to 8	1	0
Broccoli.....	5 to 7	1½	30 sec.
Green beans, cut.....	6 to 10	3 to 4	1
Green beans, frenched.....	6 to 8	3 to 4	1 to 2
Lima beans.....	10 to 15	4 to 5	1 to 2
Soybeans.....	10 to 20	3 to 5	1 to 2

Directions for Specific Vegetables

ASPARAGUS

Selection: Select young, tender, rapid-growing spears, $\frac{3}{8}$ to 1 inch thick at butt end. They should be free from woody fiber. Harvest, prepare, and freeze within 2 hours, as asparagus toughens rapidly after it is cut.

Preparation: Wash thoroughly in cold water and sort according to size. Cut stalks $4\frac{1}{2}$ to 5 inches long for quart-size containers, or in 1-inch pieces, if preferred. Freeze less tender pieces for soups and purees.

Blanching and Cooling: Blanch 2 to 3 minutes in boiling water, according to the stalk size. Cool rapidly and drain.

Packaging: Pack whole spears in containers, placing half of the heads at each end. Freeze as rapidly as possible in order to obtain a product that is not limp and tough when cooked.

BEANS, SNAP GREEN AND WAX (Bush or pole types)

Although beans may be grown successfully the year round in Hawaii the finest quality are usually raised in the cooler season. For home gardeners who have freezers, the Vegetable Crops Department of the Hawaii Agricultural Experiment Station recommends raising enough beans at one time for a 6-months' supply and freezing them. By devoting all, or nearly all, the available space to the same vegetable at one time, it is easier to control diseases and insects that attack them and to avoid perpetuating the diseases and insects by always having them transferred from one crop to the next. This is especially true for snap green and wax beans. Sufficient beans of prime, tender quality can be harvested at one time to make it worth while to freeze them.

Sufficient work has not yet been done on different varieties of beans raised in Hawaii to make specific recommendations, but young, tender Kentucky Wonder beans have been found to produce a fine frozen product.

Selection: Choose tender, crisp, stringless, medium-sized beans that have bright green or yellow pods. Discard thin pods and all bruised and discolored beans. Slightly immature beans give a more satisfactory frozen product than overmature ones.

Preparation: Sort and wash thoroughly in cold water. Snip off ends and string, if necessary. Break into 1-inch pieces, or slice lengthwise (frenched). Beans that are 2 to 3 inches long may be left whole.

Blanching and Cooling: Blanch 2 minutes in boiling water, or $2\frac{1}{2}$ to

3 minutes in steam. Frenched beans should be blanched in steam only for 3 minutes. Cool rapidly in cold running water or ice water. Drain.

Packaging: Pack in containers and freeze immediately. Rapid freezing is essential for good quality snap beans.

LIMA BEANS

Selection: Choose pods that are green and well filled with bright green, tender beans. Pods past the succulent stage may contain a large proportion of overmature white beans.

Preparation: Handle quickly to prevent deterioration in quality, especially after the beans have been removed from the pod; do not permit more than 1 hour to elapse between shelling and freezing. Sort the shelled beans to remove imperfect ones and separate the white overmature beans from the green tender ones. The former might be packaged for soup stock or used immediately. Wash the sorted beans in clean cold water.

Blanching and Cooling: Blanch in boiling water, the small-seeded types for $1\frac{1}{2}$ minutes and the large-seeded types for 2 minutes. For steam blanch, add 1 minute to the above blanch time. Thoroughly cool in running water or ice water and drain.

Packaging: Pack in containers; freeze immediately.

SOYBEANS

Selection: Soybeans lend themselves well to freezing. Since the beans are harvested by pulling up the entire plant by the roots, even in the small home garden there are usually more beans than the family wishes to eat at the time of harvest, and the surplus can easily be frozen for future use. Select pods that are bright green and well filled with tender young beans.

Preparation, Blanching and Cooling: Wash the pods thoroughly. Since most varieties of soybeans are difficult to shell, the beans may be blanched in the pod. Bring blanching water to the boiling point, add the washed beans and precook 4 to 5 minutes. Cool by plunging the beans in ice water or in cold running water. Squeeze the beans from the pods. Wash quickly in cool water and drain. Do not allow the shelled beans to stand in water.

Packaging: Pack promptly and freeze.

BROCCOLI

Selection: Choose tender, compact, firm heads of uniform dark green color with young, tender stalks about 1 inch thick.

Preparation: Wash and sort according to size. Trim off outer leaves and imperfect stalks. Let stand in salted water (4 teaspoons to 1 gallon of water) $\frac{1}{2}$ hour to remove any insects or worms. Rinse thoroughly and

trim away woody parts of the stalk. Split the stalks and heads lengthwise so that heads are about 1 inch in diameter. Peel the less tender stalks.

Blanching and Cooling: Blanch in boiling water: small stalks, 3 minutes; medium, $3\frac{1}{2}$ minutes; large, 4 minutes. For steam blanching, add 1 minute to each of the boiling blanch times. Cool rapidly in cold running water or ice water and drain well.

Packaging: Place in containers with half the heads at each end. Freeze immediately.

EDIBLE-POD (CHINESE) PEAS

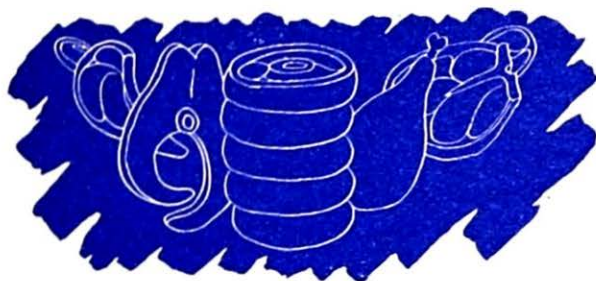
Experiments have been made using two varieties of peas, both of which yielded good frozen products. Dwarf Grey Sugar variety matures early and provides an abundance of small-size bright green pods over a long bearing period under optimum growing conditions. Mammoth Sugar variety matures more slowly and produces a large-size light green pod of exceptional sweetness.

Selection: Select young, bright green, tender pods just right for eating. Discard overmature pods and any that are bruised or discolored. Pods should be comparatively flat with small seeds or no seeds within the shell.

Preparation: Remove stem and blossom ends and wash pods in cold water.

Blanching and Cooling: Blanch $1\frac{1}{2}$ to 2 minutes in boiling water or add 1 minute to the blanch time, if steam blanching is used. A water blanch is preferred as it prevents matting of the pods. Cool rapidly to about 45° F. in ice water and drain.

Packaging: Package at once in cellophane or laminated bags, leaving $\frac{1}{2}$ -inch head space for expansion in freezing, heat seal bags, place inside carton, overwrap, and freeze.



Freezing Meats

BEEF, PORK, LAMB, VEAL

Selection

Select meat from healthy, moderately fattened animals. A good finish adds palatability to the lean, but excessive fatness is unnecessary. Select meat from young animals that will give the size of steaks and roasts desired. Meat from old, tough animals will still be tough after freezing and cooking.

Advance Preparation

Be sure a good clean job of slaughtering is done. Most spoilage results from delayed or improper chilling of warm, freshly slaughtered animals. Quickly and thoroughly chill all carcasses as soon as possible after slaughter. A chill of 24 hours at 32° to 40° F. in a room with a free circulation of air is advised. Do not chill a carcass in ice or at freezing temperatures.

Age or ripen beef and lamb but do not age pork or veal. Pork and veal lose quality more rapidly during freezer storage than do beef and lamb. Aging decreases the storage life.

Aging is chiefly for the purpose of increasing tenderness and developing flavor. It is accomplished by holding the meat in cold storage at 32° to 38° F. Beef that is to be frozen should be aged from 5 to 10 days (the longer period is recommended for well-finished beef). Longer aging periods of several weeks are not recommended, as the freezing process tenderizes the meat somewhat, and excessive aging may shorten the storage life of the beef.

Lamb may be aged from 1 to 3 days after chilling, but, in general, lamb is not improved much by aging. Age well-finished mutton from 2 to 3 days rather than the usual 5 to 7 days.

Preparation

Cut the meat as for table use—steaks, chops, roasts, stew meat, and ground meat. Remove excess fat and bone. Remove any bones which are likely to pierce the wrapping paper. Boning the cuts reduces the storage space required.

Ground meats have a shorter storage life than do the corresponding whole cuts. Salt hastens the development of rancidity; therefore omit it in frozen ground meat or use the meat within 2 to 4 months.

Packaging

Packaging materials and packaging techniques recommended for meats are given in detail in University of Hawaii Agricultural Experiment Station Circular 27, *Home Freezers and Packaging Materials*.

Poor packaging is one of the most common causes of poor-quality frozen meat. Meat must be adequately protected; otherwise it becomes dehydrated (freezer burn), it loses weight, its color fades, the texture becomes somewhat spongy, the fat becomes rancid, and the lean acquires an "off" taste and aroma.

Each package should contain just enough of the product to satisfy the individual family's needs.

Steaks and chops: Place a double thickness of cellophane between each steak or chop. This will permit their later separation without thawing if they are packed flat in carton or package. Pack into a rectangular waxed carton. Close carton, label, overwrap with moisture-vapor-proof cellophane, and heat seal. Or, wrap in specially treated vegetable parchment paper and tie with string or seal with tape.

Roasts: Wrap snugly and tightly in moisture-vapor-proof material—aluminum foil, vegetable parchment, cellophane, or pliofilm—and tie with string or seal with tape. Insert the roasts wrapped in the transparent papers in stockinette.

Ground meat: Pack in cellophane-lined cartons like those used for vegetables or in waxed tub-shaped cartons.

Patties: Package the same as steaks.

Freezing and Storage

Freeze meats immediately after packaging at 0° F. or lower. Use beef and lamb within 1 year; pork, veal, and ground meats within 6 months; and seasoned sausage and cured meats within 2 to 4 months.

Thawing and Cooking

Frozen meat can be successfully cooked from either the solidly frozen or the thawed state. The choice is chiefly a matter of management, that is, whether a longer cooking period is more convenient than defrosting ahead of time.

Thaw meats in their sealed original wrapping.

Thawing, particularly of large pieces, is time consuming. A greater amount of drip usually occurs with the more rapid thawing methods. Any of the following methods is satisfactory:

1. In refrigerator 5 to 6 hours per pound
2. At room temperature 2 to 3 hours per pound
3. Electric fan at room temperature 45 to 60 minutes per pound
4. Oven (200° – 250° F.) 25 to 30 minutes per pound

If meat is thawed, the cooking methods and times are the same as for the corresponding fresh meat.

Meat broiled or fried from the hard-frozen state tends to spatter more than does fresh or defrosted meat.

Roasts: If you wish a more uniformly done roast it is better to thaw it *before* roasting. Be sure no ice is left in the center of a thawed roast; otherwise the estimated cooking time will be too short. The temperature during thawing rises fairly rapidly and steadily to about 29° F., then the rise is very gradual (the curve forming almost a plateau) between 29° and 33° F. Consequently roasting requires a relatively long time. In a roast which has not been thawed throughout prior to cooking, this slow increase in temperature occurs in the oven. A roast cooked from the solidly frozen state may be very well cooked on the outside and still be raw and cold in the center.

Heat penetrates both fat and protein foods very slowly. Low temperatures of 300° to 325° F. are advised for the roasting of beef, lamb, and veal whether they are thawed or not. In cooking frozen roasts add from 12 to 20 minutes per pound to the recommended cooking time, or about one-half again as long, as for cooking the corresponding completely thawed, or unfrozen, roast.

The use of a meat thermometer is the only sure way of obtaining the degree of doneness desired and is particularly helpful in cooking frozen meat. If the meat is solidly frozen at the start of cooking, insert the thermometer when the meat is half done. Thermometer readings for degree of doneness are as follows:

Beef	rare.....	140° F.
	medium rare.....	160° F.
	well done.....	170° F.
Lamb	medium.....	175° F.
	well done.....	180° F.
Pork*	well done.....	185° F.

* Pork should *always* be cooked well done.

POULTRY

Selection

Freeze only healthy, plump, well-fleshed birds. Broilers should not weigh over 2½ pounds, live weight, or be over 12 weeks old. Frying chickens should be 12 to 20 weeks old and weigh 2½ to 3½ pounds, live weight. Roasting chickens should be 4 to 9 months old and weigh 3½ pounds or more. Chicken for fricassee should not be over 1 year old and may weigh from 3½ to 5 pounds. Stewing hens should not be more than 1 to 2 years old and weigh from 4 to 6 pounds.

Advance Preparation¹⁰

Proper bleeding, dressing, and evisceration are essential for good-quality frozen poultry. Poor bleeding is a direct cause of poor keeping quality, the development of undesirable flavors, and an unappetizing appearance of the carcass. Improper picking, such as overscalding or too long immersion in the scalding tank, results in a thickening of the skin and a darkening of its color. Evisceration, that is, full drawing, reduces the amount of carcass that has to be frozen and ensures more rapid penetration of the freezing temperature. If the carcass is cut up, less space is required.

There are several methods of killing and bleeding poultry. Those used for large-scale production require experience in special techniques and also equipment that is not usually available to the owner of a small flock.¹¹

For home use the following method is suggested: Suspend the bird shoulder high on a post or limb of a tree by means of a heavy cord around the bird's feet. Crossing and locking the wings over the back reduces struggling. Cut across the neck with a sharp knife and then hold the head of the bird down so as to permit free bleeding.

Soft scalding is recommended for rapid removal of the feathers. Heat water to a temperature of 128° to 130° F. and immerse birds completely for 30 seconds. Old chickens require more time. Dunking up and down increases the likelihood that the hot water will get to the skin and relax the grasp of the feather follicles. Remove feathers as rapidly as possible; but for better appearance and storage, care should be exercised against tearing the skin or roughing up the outer layer of the skin. It is generally recommended that the wing and tail feathers be removed first. Strip against the lay of the feathers, from the legs toward the head.

Drawing roasters: Cut across the joints at the hock (where the shank meets the feathered portion of the leg) and remove shanks and feet. To prevent the flesh on the drumstick from drawing up during roasting it is advisable to cut skin slightly below the hock. Cut out oil sac since it may impart an undesirable flavor. Make a longitudinal slit of skin on the back of the neck to the shoulder and sever neck at shoulder, being careful to leave enough neck skin so that when folded back the front can be closed for stuffing without sewing. Remove head from neck. Insert finger into opening and loosen crop, windpipe, and gullet. Remove these.

Make a vertical incision on abdomen near vent and continue slit around the vent. Care should be exercised so as not to cut the intestines. Insert fingers into incision and tear connective tissues supporting the

¹⁰ This section was prepared by Dr. Morton M. Rosenberg of the Hawaii Agricultural Experiment Station Poultry Department.

¹¹ Those interested in commercial methods should obtain Hawaii Agricultural Extension Service Circular 231, *Preparing Chickens for Market*, by C. M. Bice.

viscera. Place a finger on either side of the gizzard and pull rearward thereby removing the viscera. Reach in, tear loose, and remove the heart, lungs, and kidneys. If there is no blood in the body cavity washing is not necessary. Wipe dry with a clean cloth. Slit heart and remove blood. Clean gizzard, and remove gall bladder from liver. Fold neck skin over opening onto back and lock in place with tips of wings.

Drawing broilers: Remove feet and shanks as previously described by cutting across hock. Cut out oil sac on the back near the tail. Place bird on its side with back facing the cutting hand. Using a sharp knife or heavy scissors, make two lengthwise cuts through the bones the entire length of the back on both sides of the backbone. Cut around and under the vent. The backbone and neck may be stripped out easily. Remove head and cut neck away from backbone at the shoulder. Open the carcass like a book and strip out all organs. Save the heart, liver, and gizzard. Open gizzard and strip out inner lining. Carefully remove gall bladder from liver. Slit heart and remove blood. Wash all parts carefully, or if clean and no blood is on any part then thoroughly wipe with a clean dry cloth.

Drawing fryers: Directions for broilers also pertain to fryers. In addition, cut down length of breastbone thereby separating carcass into two halves. These halves are cut again into halves between the rib and thigh. Large fryers may also be disjointed in smaller portions, as fricassee-style chicken.

Packaging

For home freezing of poultry, precooling is not essential if the parcels and cartons are placed on the primary freezing area promptly after packaging, leaving space between them until they are frozen. Packing while warm permits a closer pack with less air space. Use a form-fitting wrap which keeps air pockets to a minimum.

Roasters: Wrap the giblets separately in moisture-proof paper and insert them with the neck in the cavity of the bird or under one wing. Truss the bird by tying the legs together and the wings to the breast. Wrap in moisture-vapor-proof material—cellophane, pliofilm, or aluminum foil. Seal transparent materials with tape. Overwrap all packaging materials with stockinette. Specially treated vegetable parchment paper may also be used. Label and freeze immediately.

Pre-roasted: Poultry may be roasted in the usual way, then chilled, wrapped without cutting, and frozen. It makes excellent cold, sliced chicken. If you wish to serve it hot there is little, if any, advantage in roasting it before freezing because the time required for reheating it is almost as long as for roasting the uncooked chicken. If you wish to reheat

it, place it in the oven while it is still wrapped in the aluminum foil. The foil wrapping prevents it from drying out.

Broilers: Wrap giblets in moisture-proof paper and place them along with the neck and backbone between the halves. Put a double piece of cellophane between the halves and package the same as the roasting chicken, or place in a folding rectangular waxed carton. Close carton, label, overwrap with cellophane, heat seal, and freeze.

Fryers and stewing fowls: Wrap giblets in cellophane. Pack the quarters or fricassee-style pieces in a rectangular waxed carton. Omit the bony parts of cut-up chicken such as the back, neck, and wing tips to save freezer storage space. If desired, each piece of chicken may be wrapped in cellophane for easier removal and more rapid thawing later. Close the carton, label, overwrap with cellophane, heat seal, and freeze.

Freezing and Storage

Freeze the birds immediately at 0° F. or below, and store them at the same temperature. Use within 1 year.

Thawing and Cooking

Roasters: A whole bird cooks more uniformly if the bird is entirely thawed beforehand. Thawing avoids underdone flesh next to the bone. All poultry is best when thoroughly cooked. Be sure cooking starts as soon as the bird is defrosted and while it is still very cold. Otherwise appreciable leakage may occur. Thaw in the unopened package to prevent drying of the skin. Thawing in the refrigerator, which gives the best results, requires about 4 to 7 hours per pound, the shorter time per pound for the larger birds. Or, the bird may be defrosted at room temperature—which requires about 1 hour per pound. If defrosted under cold running water, 1½ to 3½ hours are required for chickens and from 5 to 7 hours for turkeys.

Stuff and roast the same as for fresh poultry, using low heat, 325° to 350° F., to prevent drying out. Roast for from 30 to 45 minutes per pound, depending upon the size of the bird. If it is necessary to roast a bird from the solidly frozen state, use the same low temperature but increase the roasting time per pound by about one-half or longer.

Broilers and fryers: Thaw in the unopened package until the pieces can be separated. Cook as fresh poultry. If not completely thawed, allow additional cooking time and cook at a lower temperature. Broilers usually require 25 to 50 minutes broiling time.

Stewing hens: Frozen poultry may be stewed without defrosting. Since the heat from the large amount of water penetrates quickly, only a slightly longer time is required than for fresh birds. If desired, the stewing hen may be defrosted in the unopened package before cooking.

Fricassee chicken: Thaw the chicken in the unopened package and proceed as with fresh poultry. Or, thaw until pieces can be separated and cook the same as fresh birds, but increase the cooking time.

GAME

Warm, freshly killed game requires more prompt bleeding and chilling than do domestic animals. Souring is likely to develop if the animal is not chilled properly. Spoilage starts quickly in flesh that has been torn or bruised by bullets.

Experienced hunters recommend that venison be skinned and quartered immediately after killing. The quarters should be wrapped in fine meat-wrapping cloth. Age venison as recommended for beef (page 54) and freeze in the same manner as beef.

Young goat (kid) meat is highly regarded by hunters in Hawaii and should be treated as recommended for lamb (page 54).

Great care must be used in skinning wild sheep. The wool is usually badly soiled and can impart a strong oily taste to the meat. Sheep should be dressed at once and wrapped in fine mesh cloth to protect it from flies and dust. Age the carcass as recommended for lamb and freeze in the same manner (page 54).

Rabbits, and other small game animals, should be skinned, dressed, washed, and chilled promptly. Usually only the thick back and hind-quarters are frozen in order to save locker space. Package as you would broilers, or cut-up chicken.

FISH

Selection

Freeze only fresh, wholesome, well-flavored fish. Chill or ice it as soon as it is caught and never allow it to become warm. Freeze fish the day it is caught. If this is not possible, refrigerate it.

Preparation

Remove fins, entrails, head, tail, and scales. Wash thoroughly. Cleanliness is absolutely essential for a high quality product.

Freeze whole or cut into steaks or fillets.

Immerse lean fish for 20 seconds in a 10 percent brine solution (1 pound salt to 4½ quarts water) to reduce leakage when fish is thawed. Drain. This treatment is not recommended for fatty fish, as it speeds up rancidity.

An ascorbic acid dip prior to freezing helps to prevent rusting (yellowing of the surface) and rancidification of the fat. It increases the storage life of the fish by about 4 months. Dissolve 1 tablespoon of powdered ascorbic acid in 1 pint of chilled, freshly boiled water. Dip the fish in it for 20 seconds. Drain, wrap, label, and freeze the fish.

Packaging

Steaks or fillets: Wrap each piece in moisture-vapor-proof material—such as cellophane or pliofilm. Pack in flat, rectangular, waxed cartons. Close carton, label, overwrap with moisture-proof cellophane, heat seal, and freeze.

Whole: Wrap the cleaned fish in heavy, strong, moisture-vapor-proof paper and heat seal.

If desired, whole fish may be ice-glazed. Freeze the fish, and then dip it in near-freezing water. Freeze the fish without wrapping, redip at least once in near-freezing water, wrap, seal, and return to the freezer. More than two dippings may be necessary to obtain a good glaze, about 1/16 inch thick. The ice glaze is not permanent. It evaporates and may crack. It usually needs renewal every 4 to 6 weeks. Wrapping the glazed, frozen fish in vapor-resistant paper retards evaporation of the glaze. Do not put an ice glaze on fish that have been skinned, or on whole fish where flesh has been exposed.

Fish may be frozen in blocks of ice. To do this, immerse fish in ice-cold water in the proper size pan. After the fish is frozen, remove the block from the pan, wrap, and return it immediately to the freezer.

Freezing and Storage

Freeze at 0° F. or lower, and store for no longer than 6 months.

Thawing and Cooking

Thaw in the unopened package and cook immediately as fresh fish. More uniform thawing with less drip results from thawing in the refrigerator; a 1-pound package requires from 6 to 10 hours. Fish spoil readily so cook them while they are still chilled. If desired, thaw only enough to separate the pieces and then cook as fresh fish. A longer time at a lower temperature is required for cooking partially thawed fish. Fish which has not been completely thawed tends to stick to the pan and to spatter during cooking.

SHELLFISH (Crabs and Lobsters)

Preparation

Boil or steam live crabs and lobsters 15 to 20 minutes in 3 percent brine (2 tablespoonfuls salt to each quart of water) before they are frozen. After cooking, cool rapidly and pick meat from the shells. Pack meat in waxed tub-shaped cartons, or pack closely in cartons like those used for fish. Wrap in moisture-vapor-proof cellophane or metal foil, seal, and freeze. Lobster tails may be frozen in the shells.

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Thawing and Cooking

Completely thaw lobster and crab meat to be used in cocktails or salads. If the meat is to be used in cooked dishes, thaw it only sufficiently to break it apart.

Defrost lobster tails. Clip and remove under-shell and fins. Clean if necessary. Broil.

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