

OSU
Collection

calcium-firming

Summer apples

Processing
Methods

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Story in Brief

To make the kind of apple pie liked by most Americans, bakers and housewives generally prefer fruit that keeps its shape during baking. Yet most cooks find that summer-maturing apples tend to soften and lose shape as soon as heated.

In Oklahoma, fall-maturing apples retain their texture firmness better than summer-maturing ones, but they are also more susceptible to codling moth damage. Because of this moth damage, State horticulturists find that the Oklahoma apple grower would have a better cash crop if he planted only summer-maturing varieties.

To make these Oklahoma summer apples more acceptable to housewives and chefs, home economists at the Oklahoma Agricultural Experiment Station conducted tests to find if such apples could be treated to prevent or reduce this softening during cooking. Combining reports of research elsewhere with their own experiments, the economists found that treating apples in a dilute calcium chloride solution brought about satisfactory firming results.

Calcium chloride is a chemical much like common table salt and is obtainable in a granular form at drug stores. It is not a preservative and has no effect on the keeping quality of apples. It does, however, give firmness to the cell structure of apple tissue, thus preventing excessive softening when heated.

Information presented in this bulletin is for homemakers or for those using equipment commonly found in the kitchen. However, with certain adaptations, these methods could be applied for firming summer apples at the commercial level.

(See General Procedure for Firming Summer Apples and Using Them in Pies, page 20.)

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Calcium-Firming Summer Apples

Processing Methods

By EULA MORRIS

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Apple pie with a filling of plump, juicy, flavorful slices of fruit still leads the list as America's favorite dessert. To make such a pie, homemakers prefer apples with sufficient texture firmness so that slices of them will retain their shape during baking. Unfortunately, summer-maturing apples tend to soften and lose shape when heated, this characteristic somewhat limiting their use in pies.

To develop a method to firm summer apples using equipment commonly found in the home kitchen, home economists at the Oklahoma Agricultural Experiment Station conducted tests for five years on eight leading varieties of Oklahoma summer apples.¹ Using reports of research elsewhere² with their own experiments, the home economists found that a calcium chloride solution will firm summer apples by reacting with the pectic acid of the fruit, thus forming a substance which gives a firmness to cell structure. This in turn prevents excessive softening of apple tissue during heating. The calcium solution, though good for firming, is not a preservative and has no effect on the keeping quality of apples. It is a chemical much like common table salt and may be obtained in a similar granular form at drug stores.

In their experiment, the Station researchers worked with the following apple varieties: Yellow Transparent, Henry Clay, Lodi, Star,

1 Grateful acknowledgement is made to the Department of Horticulture for its cooperative support of this project and to Mr. William R. Kays for assisting with tests.

2 Baker, G. L., "Explanation of the Role of Calcium Salts in Firming Apple Slices." *Fruit Products Jour.* 26:197-198. 1947.

Esselen, W. B.; W. J. Hart, and C. R. Fellers, "Further Studies on the Use of Calcium Chloride to Maintain Firmness in Canned and Frozen Apples." *Fruit Products Jour.* 26:8-13. 1947.

Hills, C. H.; G. S. Nevin, and M. E. Heller, "The Firming of Apple Slices." *Fruit Products Jour.* 26:356-362. 1947.

Holgate, K. and Z. I. Kertesz, "The Comparative Usefulness of Various Calcium Salts in the Firming of Canned and Frozen Sliced Apples." *Fruit Products Jour.* 28:37-38. 1948.

Kertesz, Z. I., "Calcium Treatment Improves Pie Apples." *Food Packer* 28(6):30. 1947.

Dutchess, Gravenstein, Red June, and Summer Champion³. The home economists determined the amount of calcium chloride needed to obtain the firmness desired for each variety of apples when making pies using either frozen or canned slices.

The Station workers developed an easy and quick way to peel apples by hand and a way to keep peeled apples from turning brown. They also noted the best kinds of containers for packing apples for freezing, and compared pies made with frozen and canned slices to determine the best ways of baking them.

Some important facts noted from the experiment were:

1. The apple variety determines the amount of firming needed;
2. No sugar is added to apple slices to be frozen or canned; and
3. Unbaked pies which are to be frozen and stored may be made from either canned slices or from thawed, frozen slices.

Preparation of Fruit To Be Firmed

Selection of Fruit

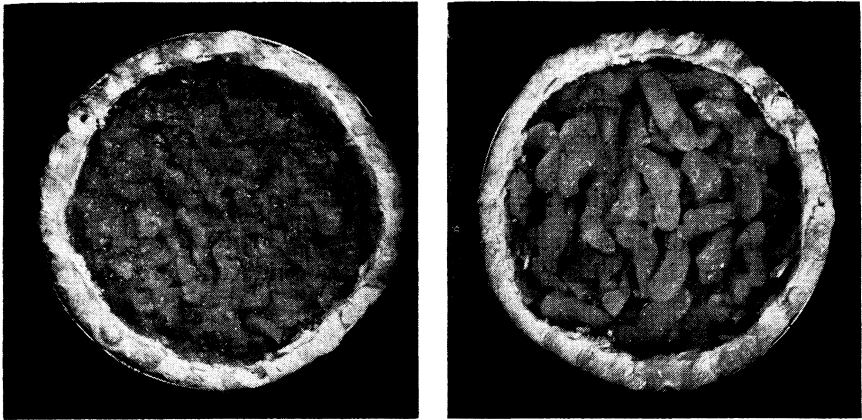
The earlier varieties show greater need for firming than do those which are harvested later in the season. For any given variety, the green or less mature apples require less firming than do those classed as firm-ripe or fully-ripe. Sound, freshly-harvested fruit yields the best quality slices.

Sort the fruit according to size, condition, and maturity or ripeness. Apples less than 1 1/2-inches in diameter yield such a minimum of fruit that it is impractical to peel and core them for pie slices. Over-ripe fruit should also be eliminated as such apples tend to break easily and are not readily affected by the calcium firming treatment. Fruit which is bruised or damaged in any way should be carefully trimmed to leave sound, clean-fleshed apple tissue.

Paring the Apples

Unless all the fruit to be pared is of uniform and symmetrical shape, a hand-operated mechanical peeler of the rotary-type blade can-

³ Data on only one season's testing are available for the Henry Clay and the Dutchess varieties. Results were considered satisfactory as indicated by these limited tests. However, at another time these two varieties may respond differently to the firming treatment; it may then be necessary to change either the scalding time for firming or the percentage concentration of the firming solution.



Both of these pies were made with Lodi apples. Fruit in the pie on the left had no firming treatment. Apples in the pie on the right were given a 3-minute firming treatment. Note how the non-treated apples became mushy when baked while the calcium-firmed apples held their shape.

not be used to advantage. Experiments have shown that when paring apples by hand, the “strip peel” method saves time as compared with any other way of hand paring (See Table I).

The strip peel method is done by cutting a circlewise strip of peel around the stem end of the apple. Continue paring by removing a vertical strip down the side of the apple going from the stem end to the blossom end. Next cut a circlewise strip around the blossom end. The peel remaining is then removed in a series of vertical strips while using single cutting strokes of the knife directed from the blossom to the stem end, this requiring but a slow rotation of the apple.

It is advisable to peel all the apples before quartering or coring them.

Sectioning Apple Quarters

The intake of calcium during the firming treatment will be more uniform if the apples are cut into slices of even thickness. The number of slices which may be cut per apple will vary according to the overall size of the fruit.

The following guide may help in deciding how many slices an apple will make:

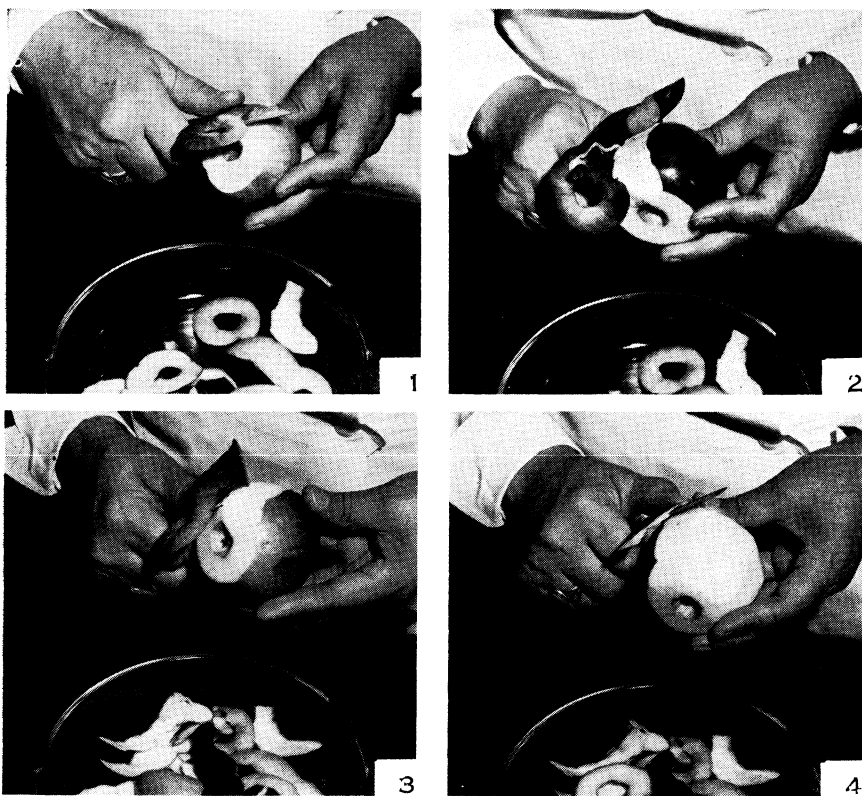
Apple 1 $\frac{1}{2}$ - to 2 $\frac{1}{4}$ -inches diameter—section each quarter into three slices.

Apples 2 ¼- to 2 ¾-inches diameter—section each quarter into four slices.

Apples larger than 2 ¾-inches diameter—section each quarter into five or more slices.

Protecting Peeled Apples from Browning

The flesh of apples tends to brown readily when the cut surface is exposed to air. This discoloration is an oxidation process which



Strip Peel Method

1. Cut circlewise strip of peel from stem end of apple.
2. Remove vertical strip from side, cutting from stem to blossom end.
3. Circlewise strip of peel is cut from blossom end.
4. Remaining peel is removed in vertical strips, cutting from blossom to stem end.

Table I.—Time Required for Peeling 12 Apples by Different Methods.

Peeling Method	Time		Remarks
	Minutes	Seconds	
I. Rotary hand peeler	6	53	Worker usually stands while operating peeler; necessary to reverse apple on holder to get all of peel removed.
II. Conventional hand paring	4	16	Worker can be comfortably seated while paring fruit.
III. Combination of I and II	4	2	Hand paring needed to remove portion missed by rotary peeler; each apple handled twice.
IV. Strip peel	3	42	Worker can sit while paring fruit; few motions required in turning fruit while paring.

may also cause changes in flavor and/or texture, making the fruit less desirable for pies. The following salt water solution protects apples from this browning:

Using four tablespoonsful ($\frac{1}{4}$ -cup) of salt⁴ per gallon of cold water, prepare a sufficient quantity of salt water to cover the amount of apples that are peeled. By pushing each apple well below the surface of the solution, the fruit may safely be held for several hours in this manner. After quartering or slicing, the fruit should be put back into the salt water, thus protecting each freshly-cut surface against browning. Just before the apples are to be calcium treated, they should be rinsed with clear water and allowed to drain.

Firming the Apples

Preparing the Firming Solution

Calcium chloride is obtainable in granular form and may be secured from drug stores. This granular form is desirable because it dissolves readily. Chlorinated lime or "chloride of lime," which is used for bleaching, should **not** be used. Because calcium chloride readily absorbs moisture from the air, it should be kept in a tightly-corked container.

A vessel large enough to hold 12 quarts of hot water, such as a water-bath canner, is convenient when working with one bushel of apples.

⁴ Non-iodized salt is advised. Although it does not get on the apples, a purple color sometimes develops in the salt water when iodized salt is used.

Table II.—Recommended Firming Solution Concentration and Scalding Time for Firming One-Half to One Bushel Apples for the Eight Apple Varieties Tested.

Apple Variety	Solution Concentration (Percent)	Calcium Chloride		Water (in quarts)	Scalding Time for Firming (in minutes)**
		Volume Measure	Weight Measure (in grams)*		
Yellow transparent, Lodi, Henry Clay,*** and Dutchess***	½	4 tablespoons	60	12	3
Gravenstein	½	4 tablespoons	60	12	4
Star	⅓	2 ⅔ tablespoons	40	12	2
Red June	¼	2 tablespoons	30	12	2
Summer Champion****	1/10	2 ½ teaspoons	12	12	3

* Weight of 1 tablespoon calcium chloride—approximately 15 grams, or ½ ounce.
 Weight of 1 teaspoon calcium chloride—approximately 5 grams, or 1/6 ounce.
 Weight of 1 tablespoon sodium bisulfite—approximately 18 grams, or 2/3 ounce.
 Weight of 1 teaspoon sodium bisulfite—approximately 6 grams, or 2/9 ounce.

** Heat calcium solution to 93° C or 202° F (just below the boiling point).

*** Results of only one season's testing available for these varieties.

**** Firming considered not necessary for frozen slices; use calcium only with canned slices for this variety.

Add the previously weighed or measured calcium chloride (See Table II) to the hot water, stirring the solution to get a uniform mixture. If apple slices are to be canned, remove a portion of the freshly-made calcium chloride solution from the vessel before any apples are treated. This will be used to fill the jars during the canning.

In all cases, the strength of the calcium firming solution and the treatment time will depend upon the variety and the condition of the apples themselves and the amount of firmness desired. As apples ripen they require more calcium to firm them. Over-ripe apples cannot be adequately firmed with calcium chloride alone as the slices tend to separate into pieces while in the solution. The solution should be prepared according to the concentration recommended for the variety of apples being used (Table II).

It is suggested that small scale testing be done prior to firming the entire quantity of apples. Firming the fruit and baking some pies will

help determine whether or not the strength of the calcium solution and the length of treatment time produces the firmness desired.

Exact proportions of the materials to use in making up the solution for small-scale testing are given in Table III.

In the process of firming apple slices, the calcium content of the solution decreases with continued usage, and the solution becomes laden with small bits of apple. For best results the solution should be discarded and a fresh one made for each bushel of apples. Furthermore, for each day that apple firming is done, a fresh solution should be prepared rather than using a re-heated, previously-used solution.

Mesh Bags for Holding Apples

Mesh bags made from cheesecloth, curtain material, or any loosely-woven fabric may be used to hold the apple slices while being firming. A 12-inch strip of curtain fabric will make an ideal 12- by 16-inch bag. The selvages will form the top edge of the bag, and a cord can be used for tying it. The bags should be loosely filled with the rinsed, drained fruit. No more than two bags should be put into the calcium firming solution at one time.

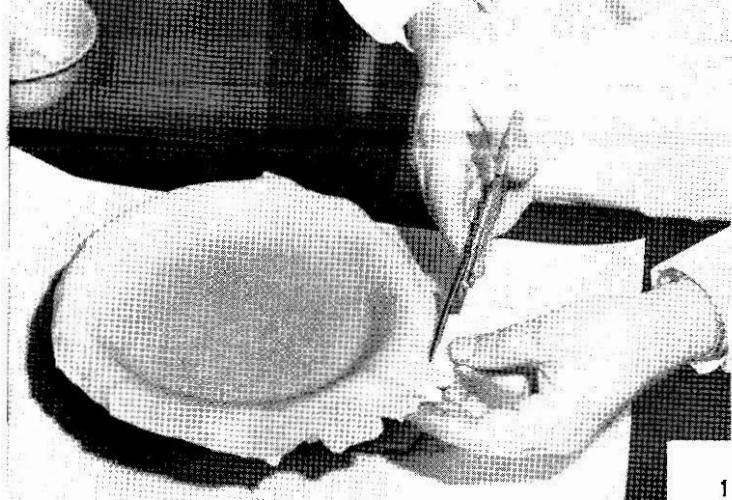
Table III.—Suggested Amount of Calcium Chloride to Use When Doing Small-Scale Testing for Determining Desirability of Firming.*

Apple Variety	Solution Concentration (Percent)	Calcium Chloride (teaspoonful)	Water (in quarts)	Scalding Time for Firming (in minutes)
Yellow Transparent, Lodi, Henry Clay, and Dutchess	1/2	4	4	3
Gravenstein	1/2	4	4	4
Star	1/3	2 2/3	4	2
Red June**	1/4	2	4	2
Summer Champion**	1/10***	4/5	4	3

* Apples for one or two pies (3 to 5 pounds) may be used with this solution when making preliminary tests.

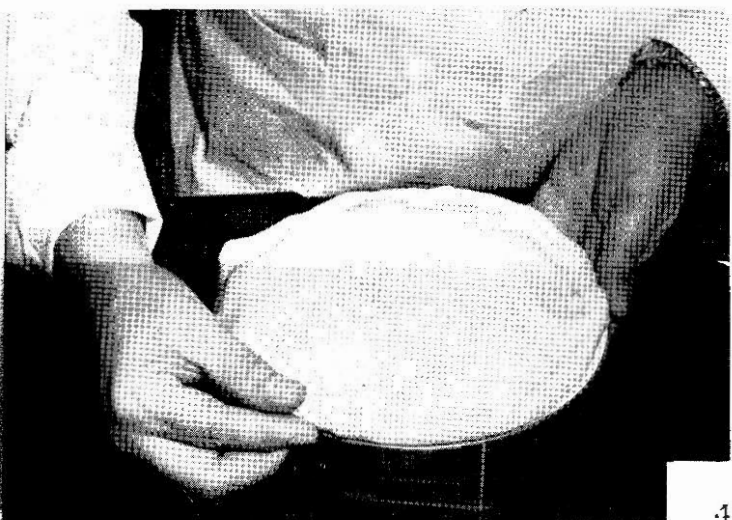
** With these apple varieties it is desirable to add lemon juice to the fruit when making pie, allowing 2 to 3 tablespoonsful lemon juice per pie.

*** Firming considered not necessary for frozen slices; use calcium only with canned slices for this variety.



Eight Steps

1. Trim lower crust $\frac{3}{4}$ inch beyond rim of pan.
2. Fruit-filled pie ready for top crust.
3. Pan-size top crust fitted in place over filling.
4. Lower crust rolled up and over forms rim which helps prevent leakage of pie juice during baking.
5. Pie ready to be frozen.





2



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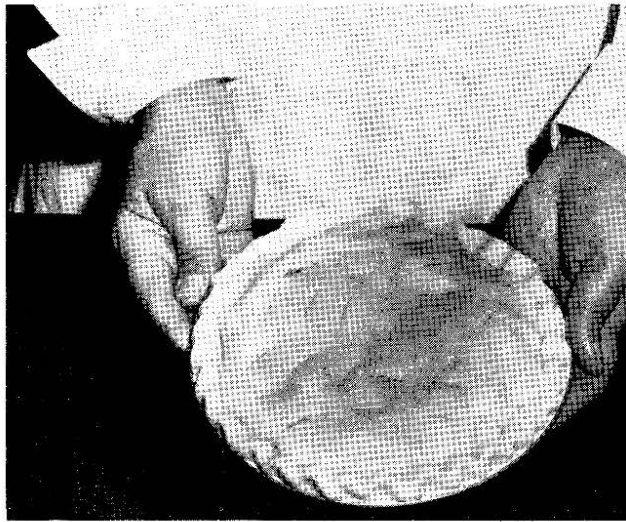
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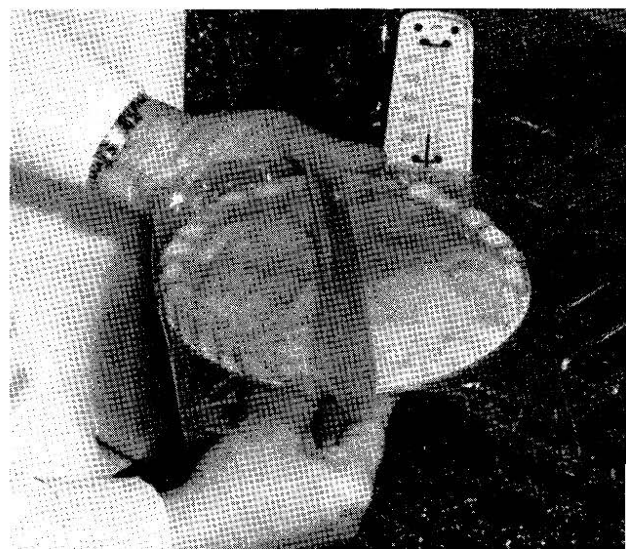
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- and stored or baked for immediate serving.
 6. Freeze pie before wrapping. Drug store wrap gives snug-fitting cover.
 7. An outer wrap will give additional protection against damage during storage.
 8. No thawing necessary before baking a frozen pie.



7



Solution Temperature

If the temperature of the solution is too high the apples will be partially cooked, causing them to soften and break. To prevent this, the apples should be given a "modified scald" treatment in which the solution is never allowed to boil. To do this the solution is heated to just under the boiling point (202° F). When the bags of raw fruit are put into it, the solution will cool a few degrees, and at no time while the apples are receiving the firming solution should the initial temperature be reached again. Only before additional bags of fruit are put into the solution should the temperature be checked and re-adjusted to that first recommended.

Timing the Process

An accurate check of time while giving the fruit the firming treatment is important as any increase in time will mean a corresponding increase in firmness. Apple slices which become too firm are tough and chewy, and will never cook tender. (See Table II for correct timing of different apple varieties.)

Timing is counted from the moment the bags of apple slices are



This picture illustrates why it is important to keep the calcium solution at the proper temperature during the firming process. The apple slices at the left were treated in a solution which was too hot; consequently, they broke and became partially cooked. Slices at the right were treated in a solution kept below 202 F. Note how each slice is still intact.

put into the hot solution. A more satisfactory firming job is assured by using a lid on the vessel and by turning the bags of fruit once during the scalding period.

Sodium Bisulfite Solution Prevents Darkening of Fruit

The short contact time with the hot calcium solution does not always afford complete protection against darkening when the frozen slices are thawed at room temperature. The Station found that sodium bisulfite was an effective material to prevent this browning.

The bisulfite solution is made by using 1 ½-teaspoonful of sodium bisulfite per gallon of cold water. Use glass, enamelware, crockery, aluminum, stainless steel, or non-chipped porcelain for holding the solution. Do not use copper, iron, tin, or galvanized containers. When the bags of fruit are removed from the hot calcium solution, they should be placed in this sodium bisulfite solution. The quantity of solution prepared should adequately cover the fruit. Allow the bags to remain two minutes in the bisulfite, then pour the slices from them into a strainer to drain.

The same bisulfite solution may be used to treat about ¼-bushel of apples. A fresh supply must then be made because the hot slices readily warm the solution.

Like calcium chloride, sodium bisulfite is available at drug stores. Either sodium bisulfite or sodium sulfite may be used, but sodium sulfide or sodium sulfate should not be accepted.

Holding Fruit Before Packing

The effectiveness of the sodium bisulfite treatment depends upon adequate penetration into the fruit. This can be assured by holding the apple slices at room or refrigerator temperature for several hours before freezing them. The fruit should be kept from four to six hours at room temperature, or overnight in the refrigerator. For fruit which is to be canned, this holding time may be reduced to but two hours.

No Sweetening Added

Whether they are to be frozen or canned, the apple slices are packed with no added sweetening. Sugar should be added only at the time of using the fruit. If fruit has sugar added prior to freezing, it is difficult to know what additional amount of sugar to use when making pie.

Freezing or Canning Firmed Apples

Bulk Packing Advised for Freezing Slices

Bags of moisture-vaporproof film, or large-size, waxed-cardboard cartons may be used when packing the apple slices. When home freezing facilities are available, containers large enough to hold fruit for four or more pies are recommended. However, the slices may be packed into small amounts sufficient for but one pie. They may be packed either before or after the holding period in which the sodium bisulfite is penetrating the fruit.

Heat Processing Necessary

When Canning Apples

Clean, sterilized quart glass canning jars should be ready for packing the drained, calcium-firmed apple slices. Avoid too tight a pack, but shake slices down in the jar to have a firm pack. No sugar is added. The packed apples are now ready to be covered with a liquid. This liquid is made from hot water and the clear calcium chloride solution reserved before treating the apples. Combine two parts calcium chloride solution with one part hot water and heat until boiling. Fill the jars to within $\frac{1}{2}$ -inch of the tops. Work out air bubbles before adjusting the lids. Process in the boiling-water bath canner for 20 minutes, counting process time when the water resumes boiling after the jars have been put in.

Using Firmed Slices

Thawing Fruit for Use

Apples should be allowed to thaw completely before using. If film bags have been used in packing the apples, avoid placing them in direct sunlight as this may cause an off-flavor in the apples. Complete thawing of the frozen slices will require four or more hours, depending upon the size carton of fruit.

Summer apples have a very high juice content. To drain and discard all this juice from thawed apple slices without benefit of heating results in the slices shriveling during baking. For this reason, thawed fruit should be turned into a sauce pan, heated to boiling, then allowed to cool before using. This will cause a re-absorption of the liquid, yielding slices which remain plump in the baked pie. Any juice not re-absorbed by the apple slices should be drained before measuring the fruit for pies.

If the slices are not to be used immediately, this heated and cooled fruit may be kept in a covered container in the refrigerator for as long as two to three weeks. However, at no time should one attempt to hold raw, thawed slices in this manner.

Preparing Pies

When preparing pie with frozen apple slices, measure 3- to 3 1/2-cups of the drained fruit for a 9-inch pie. Sprinkle 1 1/3- to 1 1/2-tablespoonsful instant tapioca over fruit and carefully stir to evenly distribute the tapioca. Let set while working with pastry to allow tapioca to take up juice from the apple slices. Sugar needed for a pie will vary with tartness of fruit. Generally 3/4- to 1 1/2-cups sugar is adequate. Spread part of sugar in lower crust before putting apples into it. Put remaining sugar on top of apples.

When preparing pie with canned slices, drain the fruit of excess juice and follow the same procedure as for frozen-apple pie.

ROLLED RIM CRUST HELPS CONTROL

PIE JUICES

The high moisture content of summer apples causes steam to develop when the fruit is cooking, thus causing juices to overflow from



These two pie cuts illustrate the difference in firmed and non-firmed summer apples. The cut at the left is from a pie using summer apples in their natural form. The fruit became mushy when baked, making the pie thin and less appetizing than the one on the right. The cut at the right is from a pie using calcium-firmed apples, the slices of which remained firm when baked.

the pie during baking. A rolled rim crust serves to prevent excessive juice leakage during baking.

When fitting the rolled pastry into bake pans, the lower crust should be trimmed $\frac{3}{4}$ -inch beyond the rim of the pan, this extension of crust to be used in making a rolled rim.

Pastry for the top crust is cut to size by inverting a bake pan of the same size on the rolled pastry and cutting around the edge of it with a knife. Vents for steam may be cut as desired. If pastry is rolled between layers of waxed paper it is best to cut the vents after the top crust is in position on the pie.

The customary practice of moistening the edges of the pastry is followed. Bring pastry extension of the lower crust up over the top crust, form into a rim roll and flute edges with fingers. This seals as well as lends a decorative edge to the pie. The prepared pie may be baked for immediate use, or it may be frozen and stored as unbaked pie until needed.

Freezing Unbaked Pies

For the most satisfactory results, unbaked pies to be frozen should be made with either the canned or the thawed slices. Greater juice leakage occurs when the freshly-firmed apples are used directly in pies intended for freezing.

Unbaked pies to be stored may be wrapped before or after freezing, but the firm-frozen, unbaked pie is somewhat easier to wrap. Too, if frozen before storage, pie pastries are rigid enough to be removed from the bake pan before wrapping. The baking utensils are then free for other uses.

Pressure from the wrapping paper may cause damage to the edge of an unfrozen pie unless protection is given to the pastry. A cardboard strip fastened collar-wise around the rim of the pie will protect the edge, or an inverted pie pan covering the pie before applying the wrapping will also prevent any injury to the pastry.

Use only recommended frozen food wrapping paper for pies which are to be freezer stored.

Baking the Pies

FRESHLY-MADE PIES

To make oven clean-up easier, a cookie sheet should be placed on

the oven rack below the pie to catch any juice which may drip from the pie.

In an oven preheated to 400° F, bake fresh pies from 40 to 45 minutes, or until as brown as desired.

FROZEN PIES

To bake a frozen pie, take it from the freezer, remove wrapping and place it, still frozen, in an oven preheated to 425° F. No thawing is necessary before baking.

After 20 minutes, reduce heat to 375° F and finish baking. Approximately 40 to 50 minutes baking time will be needed after the oven temperature has been reduced, or bake until the pie has been desirably browned.

IMPROVING PASTRY BROWNING

The browning of pie pastry is improved by the addition of one tablespoonful sugar and one teaspoonful beaten egg per pie with the water used for moistening the dough. Mixing the sugar, egg, and water together permits a more even blending of these ingredients with the flour than when adding them separately.

Egg yolk may be substituted for the whole egg without showing any appreciable difference in browning quality. However, pastry moistened with only sugar and water or with egg and water will not brown as uniformly or as readily as when using a combination of the three.

General Procedure for Firming Summer Apples and Using Them in Pies

General Steps*	Steps for Frozen Slices Only	Steps for Canned Slices Only
1. Sort or grade apples according to size, condition and maturity.	—	—
2. Strip peel the apples. (See page 8 illustrating this method.)	—	—
3. Hold the peeled whole or quartered apples in salt water to prevent discoloration of the cut surfaces. (1/4-cup salt per gallon of water.)	—	—
4. Cut apples into slices of uniform thickness. For apples: 1 1/2 to 2 1/4 inches diameter —3 slices per quarter. 2 1/4 to 2 3/4 inches diameter —4 slices per quarter. 2 3/4 or more inches diameter —5 slices per quarter.	—	—
5. Make calcium chloride firming solution according to concentration recommended for apple variety.** (See Table II, for measurements and time, in minutes, for treatment.)	—	5. Reserve a portion of the fresh solution to use for filling jars of canned slices. (Step 8.)
6. Allow apples to remain for 2 minutes in sodium bisulfite solution after firming treatment. (Solution is made from 1 1/2-teaspoonsful bisulfite per gallon of water.)	—	—
7. Drain slices well.	7. Let slices set 4 to 6 hrs. at room temperature, or hold overnight in refrigerator before freezing.	7. Allow apples to set for 2 hours.
—	8. Package slices. This can be done either before or after holding slices. Add no sugar.	8. Pack slices into sterilized, glass jars. Add no sugar. Using fresh calcium chloride solution reserved for canned slices (step 5), mix 2 parts solution with 1 part water, heat to boiling and fill jars. Adjust lids for

(General Procedure, Continued)

			processing; process 20 minutes in boil- ing-water bath can- ner.
—	9. Freeze and store.		—
—	10. FOR PIES—com- pletely thaw frozen slices, heat to boil- ing and allow fruit to cool in its own juice. Thoroughly drain all juice be- fore using slices in pies.	10. FOR PIES—com- pletely drain all juice from canned slices before using in pies.	
11.	Allow 3- to 3 ½-cups apple slices for a 9- inch pie.	—	—
12.	Mix 1 ⅓- to 1 ½-table- spoonful instant tapioca with apple slices; allow to set while pastry is prepared.	—	
13.	For each pie, add 1 table- spoonful sugar and 1 tea- spoonful egg to water used for moistening the dough. This improves browning of the crust.	—	
14.	Trim lower crust ¾-inch be- yond the rim of bake pan, using extension for rolled rim to retain pie juices dur- ing baking. (See step 17.)	—	
15.	Sugar needed for pie will vary with tartness of fruit. Generally ¾- to 1 ½-cups sugar is adequate. Spread part of sugar in lower crust before putting apples into it. Put remaining sugar on top of apples.	—	
16.	Cut top crust exact size of bake pan. Fit in place over fruit.	—	
17.	Make rolled rim edge using extension of lower pastry to form a continuous roll. Decorate edge as desired.	—	—

* The treatments for frozen and canned apple slices are generally the same. Steps that differ for the two are included in their respective columns to the right of the "general steps."

** Fruit which has become too firm with calcium is tough, chewy, and will not cook tender. Because of this, it is advisable to give only a few apples the firming treatment at first. This will test whether or not the firmness secured is satisfactory for the particular apple variety being treated. If the texture of the apples is too firm, then a reduction in "scalding time" is advised. (See page 12 detailing this step.)

