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Strawberries: Safe Methods to Store, Preserve, and Enjoy

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WHAT IS A STRAWBERRY?

The strawberry (*Fragaria x ananassa* Duch.), a member of the rose family, is not really a berry, but an achene or “false” fruit (fig. 1). A strawberry consists of many tiny individual fruits embedded in a fleshy scarlet receptacle. The brownish or whitish specks, commonly considered seeds, are the true fruits, known as achenes. Each achene surrounds a tiny seed. These berry components make strawberries relatively high in fiber. Strawberries are also an excellent source of vitamin C, a good source of folate and potassium, and are relatively low in calories (fig. 2).

The strawberry is native to temperate regions around the world, including parts of North America. California grows approximately 83 percent of the nation’s strawberries (1.4 billion pounds of strawberries annually) that are marketed as fresh or frozen fruit. Strawberries are grown on over 25,000 acres in California, each producing an average of 21 tons of strawberries, seven times the national average. Strawberries are grown in five regions of California: San Diego, Orange County, Oxnard, Santa Maria, and Watsonville/Salinas. The California strawberry season extends from January through November along the California coast, with its peak in April, May, and June, when all five districts produce berries at once. Florida produces strawberries in the winter months (November through January), and additional berries are imported from Mexico during this time.

The most common commercial varieties in California are the Camarosa, Diamonte, Chandler, and Selva. Proprietary and other varieties, representing about 32 percent of acreage, are bred and grown for individual shipping companies, and are not available to the public.

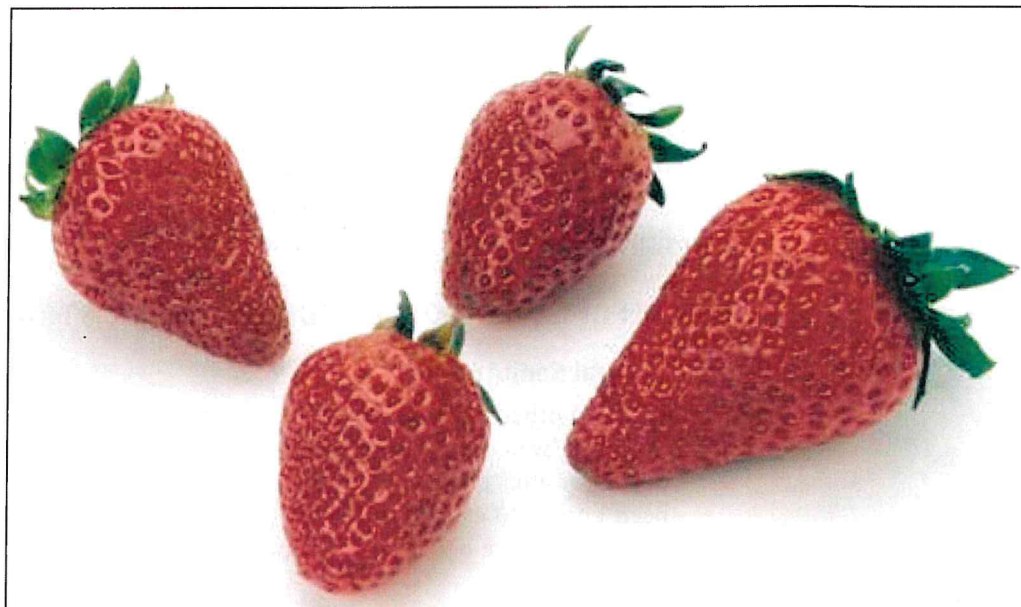


Figure 1. Photo of ripe strawberries.

Nutrition Facts	
Serving Size (144 g)	
Amount Per Serving	
Calories 46	Calories from Fat 4
% Daily Value*	
Total Fat 0 g	1%
Saturated Fat 0 g	0%
Cholesterol 0 mg	0%
Sodium 1 mg	0%
Total Carbohydrate 11 g	4%
Dietary Fiber 3 g	12%
Sugars 7 g	
Protein 1 g	
Vitamin A 0%	Vitamin C 141%
Calcium 2%	Iron 3%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.	

Figure 2. Nutrition facts for whole strawberries (1 cup). Source: USDA National Nutrient Database.

GROWING STRAWBERRIES IN THE HOME GARDEN

Information on growing strawberries is available online through the University of California, Davis, Fruit and Nut Research and Information Center homepage: <http://fruitsandnuts.ucdavis.edu/>. The site also contains useful information on strawberry pest and disease management, and control of disorders, such as black root rot, gray mold, nematode problems, wilting, and virus diseases.

A free online publication from the University of California, *Key Points of Control and Management of Microbial Food Safety: Edible Landscape Plants and Home Garden Produce* (UC ANR Publication 8101), provides information on ways to minimize contamination of fruits and vegetables in the home garden by organisms that cause foodborne illness. You can access the publication at <http://anrcatalog.ucdavis.edu>. Additional information on handling strawberries after harvest is available online at <http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/strawberry.shtml>.

SELECTING STRAWBERRIES FROM THE HOME GARDEN OR PICK-YOUR-OWN SITE

Strawberries do not ripen after they are harvested, so it is important to pick the fruit at the right stage of maturity. Pick when the berry surface is fully red, without green or white areas—this fruit will contain the maximum sweetness and flavor. Strawberries that are deep red and dull in appearance are overripe and may be very soft.

Harvest strawberries by gently snapping the pedicel (stem) from the plant. Take care to avoid bruising the berries. Cool the freshly picked berries as soon as possible after harvesting, and store the fruit in the refrigerator until use.

SELECTING STRAWBERRIES AT THE GROCERY STORE

Select strawberries that have a bright, glossy appearance and maximum red color development. Avoid fruit with signs of spoilage, shriveling, mushiness, or a dull appearance.

STORING FRESH STRAWBERRIES

The optimum storage temperature for strawberries in the home is 32° to 36°F (0° to 2°C). The optimum humidity for storage of berries to prevent water loss and shriveling is 90 to 95 percent. Store the fruit in the crisper drawer of your refrigerator. Keep strawberries packaged in closed plastic clamshell containers or place fruit in a partially opened plastic bag to maintain high humidity. Do not wash berries until just before eating or preserving. Washing will add moisture and will cause the berries to spoil more rapidly. Strawberries can only be stored for up to 7 days under optimum conditions, and that shelf life also depends on how ripe the fruit was when purchased or picked.

SAFETY TIPS FOR HANDLING FRESH STRAWBERRIES

General Sanitation

Like any other fresh fruit or vegetable, strawberries can be contaminated with bacteria from soil, water, and animal sources. Contamination from human sources may occur during or after harvest, right up to the point of eating. Contaminated produce has been known to cause foodborne illness. Food poisoning outbreaks with other types of produce have occurred when poorly washed utensils or cutting boards (especially

those used to handle raw meats) were used to prepare fresh fruits or vegetables. For this reason, it is important that you wash your hands with soap and water before and after preparing produce, and use clean equipment, utensils, and cutting surfaces.

Washing Strawberries

Strawberries should be washed just before eating or preserving. To wash, rinse strawberries thoroughly under cool running water, drain in a clean strainer, and pat dry with a clean paper towel. For maximum cleaning, gently rub each berry under the running water.

Washing strawberries in a sink filled with water is not recommended since the standing water can spread contamination from one berry to another. The use of soap or detergent is not recommended or approved for washing fruits and vegetables because the produce can absorb detergent residues.

Cutting Strawberries

Sort fruit and discard unripe, overripe, or defective fruit. Remove and discard the green cap (leafy part) before slicing berries. Wash hands, knives and surfaces before and after preparation of berries. To maintain quality, cut or sliced strawberries should be covered and refrigerated if they are not eaten within 2 hours of preparation.

NOTE

For best quality, cut or sliced strawberries should be covered and refrigerated if not eaten within 2 hours of preparation.

NOTE

Canning strawberries is not recommended—freezing the fruit gives a far superior product.

METHODS FOR PRESERVING STRAWBERRIES

Strawberries are acidic. The pH (measure of acidity) of whole, ripe strawberries ranges from 3.3 to 3.6. Freezing, drying, and making jams and jellies are some of the best ways to preserve strawberries.

FREEZING STRAWBERRIES

Select firm, fully ripe, red berries, preferably with a slightly tart flavor. Wash and sort berries according to the method described under “Washing Strawberries” above, and remove the caps. You will need about $\frac{2}{3}$ quart of fresh strawberries to prepare a pint of frozen berries. For approximate equivalents between U.S. and metric systems of measurement, a conversion table is provided at the end of this publication.

Strawberries may be frozen whole, sliced, crushed, or puréed, depending on their intended use in recipes. Large strawberries give a better product when sliced or crushed before freezing. Frozen strawberries can be substituted for fresh berries in recipes, but thawed whole berries will have a much softer texture than the fresh fruit. Frozen whole strawberries are best served with a few ice crystals still remaining—if thawed completely, the berries will be mushy. Syrup and sugar packs produce higher quality frozen strawberries, with a better flavor and texture, than berries packed without sweetening.

Containers for freezing

Rigid plastic containers and glass freezing and canning jars make good freezer containers. The glass in these jars has been tempered to withstand heat and cold. Glass jars not designed for freezing can easily break in the freezer. Flexible plastic freezer bags also work well. Ordinary waxed paper cartons from ice cream or milk do not work well because they do not keep air or moisture from moving in or out of the container and they are difficult to clean.

Table 1. Headspace (inches) needed between packed food and lid for freezing fruit

Type of pack	Container with wide top opening		Container with narrow top opening	
	Pint (in)	Quart (in)	Pint (in)	Quart (in)
liquid pack*	½	1	¾†	1½
dry pack‡	½	½	½	½

Notes: *Strawberries packed in sugar, syrup, juice, or water; crushed or puréed berries; strawberry juice.

†Headspace for freezing strawberry juice should be 1½ inches.

‡Fruit tightly packed without added sugar, sweeteners, or liquids.

Syrup pack for whole berries

To make the very heavy (50%) sugar syrup recommended for this type of pack, dissolve 4 cups of sugar in 4 cups of lukewarm water. Stir until the solution is clear. Chill before use. Pack prepared berries into containers and cover with cold syrup. Leave the appropriate headspace, as described in [table 1](#). Keep the berries submerged in the syrup by placing a small piece of crumpled waxed paper or parchment paper on top of the fruit in each container. Seal the containers and freeze.

Sugar pack for whole berries

For each quart of prepared strawberries, add ¾ cup of sugar and mix gently until most of the sugar has dissolved, or let stand 15 minutes. Pack berries into containers, leaving the appropriate headspace (see [table 1](#)). Seal the containers and freeze.

Dry pack (unsweetened)

The dry pack is good for small whole strawberries and for freezing whole or sliced berries (without sugar) to use later in making jam. You can simply pack prepared fruit into containers, seal, and freeze. Or you can spread a single layer of prepared berries on shallow trays and freeze until hard. Immediately pack the frozen berries into freezer bags or containers to prevent freezer burn. These berries remain loose so that portions of frozen fruit can be poured easily from the container. The package can then be re-closed and returned to the freezer.

Other unsweetened packs

In addition to dry pack, strawberries can be packed in water, unsweetened juice, or pectin syrup. Unsweetened packs generally yield products that lack the plump texture and good color of fruit packed with sugar. The berries freeze harder and take longer to thaw. Fruit packed in pectin syrup may retain its texture better than if frozen in water or juice.

Pack the strawberries in containers and cover with water, juice, or pectin syrup (pectin syrup preparation is described below), leaving the appropriate headspace (see [table 1](#)). Keep the fruit submerged by placing a small piece of crumpled waxed paper or parchment paper on top of the berries in each container. Seal the containers and freeze.

Pectin syrup

Combine 1 package of powdered pectin with 1 cup of water in a saucepan. Heat to boiling and maintain the boil for 1 minute. Remove from the heat and add 1¾ cups of water. Add more water if you want a thinner syrup. Cool. Yield is about 3 cups of moderately thick syrup.

Using artificial sweeteners

Strawberries can be packed in a sweet solution made by mixing water with sugar substitutes such as saccharin (e.g., Sweet'N Low), aspartame (e.g., Equal), or sucralose (Splenda). These artificial sweeteners work well in frozen products, or you can add them to the unsweetened, thawed fruit just before serving.

Artificial sweeteners give a sweet flavor but do not provide the beneficial preservation effects of sugar, color protection, or thickness of syrup. The label on a sweetener package will tell you how much sweetener is equivalent to standard amounts of sugar. Use the label directions to determine the amount needed.

Freezing sliced or crushed berries

Wash and sort berries as described under “Washing Strawberries” above, and remove caps. Slice berries, or crush partially or completely. To each quart of prepared berries, add up to $\frac{3}{4}$ cup of sugar, if desired. Mix thoroughly and pack into containers, leaving the appropriate headspace (see table 1). Seal the containers and freeze.

Freezing strawberry purée

Wash and sort berries as described under “Washing Strawberries” above, and remove caps. Crush berries, press through a fine sieve, or purée in a blender or food processor. Mix up to $\frac{3}{4}$ cup of sugar with each quart of purée, if desired, stirring until sugar is dissolved. Pour purée into containers, leaving the appropriate headspace (see table 1). Seal the containers and freeze.

Freezing juice

Wash and sort berries as described under “Washing Strawberries” above, and remove caps. Crush berries and strain through a jelly bag. Juice may be sweetened with $\frac{3}{4}$ to 1 cup of sugar for each quart of juice, if desired. Pour juice into glass freezing and canning jars or rigid plastic containers, leaving a 1½-inch headspace (see table 1). Seal the containers and freeze.

Sealing, labeling, and storing

Before you close the containers, make sure sealing edges are free of moisture or food. Leave sufficient headspace in rigid containers to allow for expansion of food as it freezes (see table 1). Placing a small piece of crumpled waxed or parchment paper between the fruit and the lid of liquid-packed strawberries will help keep the berries submerged. Do not use aluminum foil because it will partly disintegrate as it reacts with the acids in the fruit. Seal each container tightly. Label containers plainly—include name of food, date, and type of pack.

Freeze packaged strawberries as quickly as possible at 0°F (−18°C) or below. For quickest freezing, place containers in single layers in the freezer. Freeze no more than 2 to 3 pounds of fresh food per cubic foot of freezer space at one time—a larger amount will raise the temperature in the freezer and lengthen the freezing time. The fruit should be thoroughly frozen within 24 hours and then you can rearrange the containers to store them more closely together.

Most fruits maintain high quality for 8 to 12 months at 0°F (−18°C) or below. Unsweetened strawberries lose quality faster than those packed in sugar or syrup. Fruits stored longer will lose quality but will continue to be safe to eat.

DRYING STRAWBERRIES

Drying (dehydration) is the process of slowly removing water from food in order to preserve the food. Strawberries are considered fair to good candidates for drying.

Oven drying

It is possible to dry strawberries in your kitchen oven, but we do not recommend it since it takes so long: up to 18 hours to dry the berries adequately. The process heats up the kitchen, makes the oven unavailable for other uses, and is unsafe in homes with small children. If you wish to pursue oven drying, please consult other reliable references on the subject. One good online source is *Preserving Food: Drying Fruits and Vegetables*, available at <http://www.uga.edu/nchfp>.

Microwave drying

Do not attempt to use a microwave oven to dry strawberries. Fruit requires constant attention during drying, and the oven door would have to be opened frequently to allow moisture to escape. Microwave-dried strawberries do not dry evenly and can easily scorch or burn.

Sun drying

The high sugar and acid content of strawberries makes them safe to dry outdoors when conditions are right for drying (minimum temperature of 85°F [29°C] and humidity less than 60 percent). However, insects and birds are attracted to drying berries, and may contaminate them. If you wish to try sun drying, please consult other reliable references such as the site listed under “Oven drying,” above.

Dehydrator drying

Unlike sun drying, which depends on proper weather conditions, dehydrator drying can be done at any time. There is an initial expense involved in buying a dehydrator (fig. 3), but many people think that a dehydrator produces the best quality dried food. An electric dehydrator can maintain low, even temperatures, circulating the heated air by means of a blower or fan. Most dehydrators are equipped with thermostats to maintain a constant temperature, and some have timers. Larger units with many shelves have room for more food than most ovens.

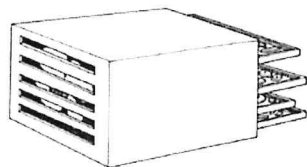
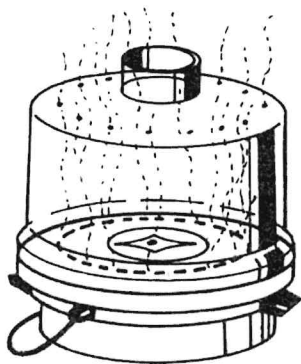


Figure 3.
Typical home dehydrators.

Preparing strawberries for drying

Wash and sort fruit as described under “Washing Strawberries” above, and remove caps. Sweeter berry varieties with a full red color and firm texture dry best. Strawberries may be sliced (¼-inch thick), halved, left whole (small berries), or puréed. No further pretreatment is required. Sliced strawberries will dry more evenly than whole berries. An excellent way to dry strawberries is to make fruit leather out of a strawberry purée (see “Strawberry fruit leather,” below).

Dehydrating strawberries

The secret to dehydrating strawberries successfully is to control the temperature and air circulation. If you use too low a temperature (less than 90°F [32°C]), the berries will dry too slowly, giving mold a chance to grow. At temperatures of 170°F (77°C) or more, the berries cook or harden on the outside and the inside remains moist and can spoil later.

Set the dehydrator temperature at 135° to 140°F (57° to 60°C), the optimum drying temperature range. If your dehydrator does not have a thermostat, place an accurate, easy-to-read thermometer on the bottom tray. Arrange the prepared

strawberries on the drying trays, cut-side up (if cut) and in a single layer. The pieces should not touch or overlap. Leave 1 to 2 inches between trays in the dehydrator. It may be necessary to turn the berries and rotate the racks' positions up and down the stack during the drying process. Continue dehydrating until the berries test dry, as described below under "Testing for dryness." Food dries much more quickly and scorches easily toward the end of the drying time, so watch it closely and remove individual strawberry pieces as they dry.

The amount of time it takes to dry strawberries depends on their initial moisture content, the volume being dried, the size and thickness of the pieces, the air's humidity during the drying process, and the dehydrator's efficiency. The estimated time for drying sliced strawberries is 7 to 15 hours, and for whole berries from 24 to 36 hours, depending on the size of the pieces and the individual dehydrator used.

Testing for dryness

To test for dryness, remove several strawberry pieces from the dehydrator. After they have cooled, cut the pieces in half. There should be no visible moisture, and you should not be able to squeeze any moisture from the pieces. Some strawberries may remain pliable, but they should not be sticky or tacky. If you fold a piece in half, it should not stick to itself.

After drying, cool the fruit for 30 to 60 minutes before packaging. Avoid packaging warm fruit, since that could lead to sweating and moisture buildup. You should also avoid long delays before you package because the strawberries may have an opportunity to reabsorb moisture from the air.

Conditioning dried strawberries

Since strawberries are generally eaten without being rehydrated, they should not be dried to the point of brittleness. The water content of home-dried strawberries should be about 20 percent. When you take the berries from the dehydrator, the pieces may not have the same moisture level because of their size or where they were located in the dehydrator. *Conditioning* is the process used to make sure that all pieces are equally moist. This reduces the risk of mold growth.

To condition the strawberries, pack the dried, cooled fruit loosely in clean plastic or glass jars. Seal the containers and allow them to stand for 7 to 10 days. Excess moisture in some pieces will be absorbed by the drier pieces. Shake the jars daily to separate the berries, checking for any water condensation. If condensation develops in a jar, return the fruit to the dehydrator for further drying. After conditioning, package and store the fruit.

Packaging and storage

Dehydrated berries require very little storage space. Completely dried strawberries can be stored in sealed plastic bags or airtight jars and cans. Pack the strawberries tightly in the bag or container, removing as much air as possible. If you use metal containers, place the fruit in a plastic bag first in order to prevent reaction with the metal. The dried fruit should be stored in a dark, cool (60°F [15°C]) place. The berries' color, flavor, aroma, and nutritive value will start to decrease after about a year. For longer storage, you can keep well-wrapped dried strawberries in the freezer. For best flavor and quality, use within 2 years of frozen storage.

Check dried strawberries occasionally during storage to make sure the product is still dry. Glass containers are excellent for storage because any moisture that collects

on the inside is easily seen. Strawberries that are affected by moisture but not spoiled should be used immediately or redried and repackaged. Moldy strawberries should be discarded.

Using dried strawberries

Home-dried strawberries can be eaten as a snack, mixed with dry or cooked cereals, and added to milkshakes and homemade ice cream. Dried strawberries can also be powdered to flavor fruit beverages.

Strawberry fruit leather

Fruit leathers are homemade dried fruit rolls. Fruit leathers are made by pouring puréed fruit onto a flat surface and drying. When dried, the product is pulled from the surface and rolled. The fruit roll is shiny and has the texture of leather.

Select ripe or slightly overripe but not spoiled strawberries. (You can use fruits with minor blemishes and bruises that are not suitable for canning or freezing, if you remove the imperfections.) Wash the fruit as recommended above, and remove caps. Cut berries into slices or chunks. To make a mixed-fruit leather you can cut up kiwi or other fruits to add to the strawberries. Use 2 cups of prepared fruit for each 13 by 15 inch fruit leather.

Preheating the berries before puréeing is recommended—it helps to destroy bacteria and molds that may be present on the fruit, preserves the natural color of the berries, and speeds up the drying process. Place prepared berries in a microwaveable casserole dish, cover, and microwave on full power (high) for 6 to 8 minutes per 2 cups of fruit, stirring every 2 minutes until the fruit is soft and has reached 160°F. Alternatively, place prepared berries in the top of a double boiler, cover, and steam over boiling water for 10 to 15 minutes.

Purée the heated fruit until smooth. Strain to remove seeds, if desired. To prevent darkening of the fruit leather during drying, you can add 2 teaspoons of lemon juice or ¼ teaspoon of ascorbic acid for each 2 cups of fruit. (You can buy pure ascorbic acid crystals from pharmacies and also in the canning supply section of some supermarkets and hardware stores.)

Optional: to sweeten, you can add 1 to 2 tablespoons of corn syrup, honey, or sugar for each 2 cups of fruit. Corn syrup or honey will not crystallize so these sweeteners are best for leathers that will be stored for longer than a few months. Sugar is fine as a sweetener for making leathers that will be used immediately or within a few months. If you prefer to add artificial sweeteners to reduce the tartness of the fruit purée, use a sucralose sweetener (Splenda). Saccharin-based sweeteners may turn slightly bitter if added to the fruit and then heated, and aspartame sweeteners may lose sweetness during drying.

For oven or sun drying of fruit leathers, line cookie sheets with plastic wrap. In a dehydrator use plastic wrap on the trays, or use specially designed plastic sheets available for dehydrators. Pour purée onto the trays or sheets and spread out to a thickness of ⅛ to ¼ inch in the center; the edges can be slightly thicker since they will dry faster. Dry the fruit leather at 140°F (60°C) for about 4 to 8 hours in a dehydrator, up to 18 hours in the oven, or up to 1 to 2 days in the sun. Properly dried fruit leather is ready if no indentation remains when you touch the center of the leather with your finger, and it peels away easily from the wrap. Peel leather from the plastic wrap while still warm. Cool, roll loosely in clean plastic wrap, and store in an airtight container in a cool, dry place.

FREQUENTLY ASKED QUESTIONS

What is the white mold that grows on my strawberries and how can I prevent it?

The white growth is actually a common fungus, *Botrytis cinerea*, found on strawberries and many other fruits. The spores, or single-celled “seeds,” of *Botrytis* are found on nearly all harvested strawberries, but particularly when they are harvested during wet weather. To reduce the growth of the fungus, store strawberries in the refrigerator. Eat strawberries within a few days of purchase and wash them just before eating.

Does the degree of red color on the strawberry indicate its flavor quality?

As the strawberry ripens on the plant, the surface color changes from green to white to pink to red. However, there is some variation from one variety to the next. Some berries only attain a light red or orange color when fully ripe. Strawberries that are picked fully ripe have optimal eating quality. Look for fruit without green or white color on the surface, but, in addition, avoid berries that are very red, but dull in appearance, which may indicate over-ripeness.

ADDITIONAL RESOURCES

UC Food Safety at UC Davis provides information about food safety and has links to resources on home food preservation.

<http://www.ucfoodsafety.ucdavis.edu>.

The National Center for Home Food Preservation provides science-based information on home food preservation for Extension educators, other educators, and home food preservers. <http://www.uga.edu/nchfp>.

University of Georgia College of Family and Consumer Sciences, Food Safety and Preservation Section provides extensive publications on preserving food safely, and other food-related information.

<http://www.fcs.uga.edu/ext/pubs/index.php>.

The University of California Fruit and Nut Research and Information Center at UC Davis provides information on growing strawberries in the home garden. The site contains useful information on strawberry pest and disease management, and control of disorders. <http://fruitsandnuts.ucdavis.edu/>.

The Postharvest Technology Research and Information Center at UC Davis provides information on storing fresh fruits and vegetables.

<http://postharvest.ucdavis.edu>.

Approximate metric equivalents

U.S. unit	Metric
1 teaspoon (tsp)	5 milliliters (ml)
1 tablespoon (tbsp)	15 milliliters (ml)
1 ounce (oz)	28 grams (g)
1 cup	250 milliliters (ml)
1 pint (pt)	500 milliliters (ml) or 0.5 liter (l)
1 quart (qt)	1 liter (l)
1 gallon (gal)	4 liters (l)
1 bushel (bu)	35 liters (l)
1 pound (lb)	454 grams (g) or 0.45 kilogram (kg)
1 inch (in)	2.5 centimeters (cm)
1 foot (ft)	0.3 meters (m)

NOTE: Research on food preservation is ongoing—recommendations may change. Make sure your food preservation information is always current. Always follow up-to-date, tested guidelines and recipes from reliable sources. 4/2007

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FOR MORE INFORMATION

You'll find detailed information on many aspects of food preservation and preparation in these titles and in other publications, slide sets, CD-ROMs, and videos from UC ANR:

Apples: Safe Methods to Store, Preserve, and Enjoy (ANR publication 8229), 2007.

Cantaloupe: Safe Methods to Store, Preserve, and Enjoy (ANR publication 8095), 2003.

Oranges: Safe Methods to Store, Preserve, and Enjoy (ANR publication 8199), 2006.

Peppers: Safe Methods to Store, Preserve, and Enjoy (ANR publication 8004), 1998.

Safe Methods of Canning Vegetables (ANR publication 8072), 2003.

Tomatoes: Safe Methods to Store, Preserve, and Enjoy (ANR publication 8116), 2004.

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