



William T. Kemper Center for Home Gardening

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Storage of Fruits and Vegetables

Year-long supplies of fresh food have been made possible by improvements in controlled storage conditions, shipping and importing. A fresh weekly food supply at the local supermarket has eliminated the need for the home preservation and food processing of earlier days. Today, we may choose to preserve and process food for reasons besides availability such as the price of food, quality and nutrition. For these reasons, gardeners who find themselves with a surplus of fresh produce at the end of the season may decide to store and preserve.

There are five methods of storing vegetables and fruit: drying, canning, curing and salting, freezing and common storage. Which method is chosen depends upon the type of produce, the quality desired and the facilities available for storage.

Regardless of the method chosen, some general rules should be followed:

1. Use only fresh produce.
2. Begin the preservation process immediately after harvest.
3. Avoid damaged, cut, bruised and pest or disease infested produce.
4. Use all preserved produce within one year of storage.

Methods of Preservation

Drying

One of the oldest ways to preserve produce is through drying. The basic procedure involves removal of moisture from the produce to a point where decay is not likely. This can be done by using an oven, a dehydrator or the warm heat of the sun. Once finished, the produce should be stored in a dry place in air tight containers. Dried produce does not retain the quality and nutritional value found with fresh produce. The process is also fairly labor intensive and time-consuming. However, certain produce, such as beans, peas and other legumes, can be dried without much loss.

Canning

A resurgence of interest in canning is taking place as it has become easier with more fool-proof methods and good equipment like regular jars, lids and more reliable and safer pressure cookers. With the pressure cooker method, the produce is heated to kill microorganisms that can cause spoilage. This action also deactivates enzymes in the produce that affect flavor, texture and color. Canning can incur added costs with

the purchase of equipment, containers and general supplies. It also is labor intensive. For most types of produce, higher food quality can be maintained with canning rather than drying.

Curing and Salting

If certain garden produce is allowed to ferment naturally, it is said to have become “cured.” This means that microorganisms initiate the fermentation process and change the food quality without causing bad tastes or generating toxins. The best example of natural curing is with cabbage that ferments into sauerkraut. During the fermentation process large amounts of acids are produced which control the fermentation process by ultimately limiting the microbial action as the food becomes more acidic. A second way to cure food is by adding organic acid like vinegar to increase the acidity and limit microbial activity. When salt is added in sufficient quality, this too will control microbial action and effectively stop the growth of spoilage organisms. Curing and salting is not a common method of preserving garden produce because of the great change that it makes in the quality and overall taste.

Freezing

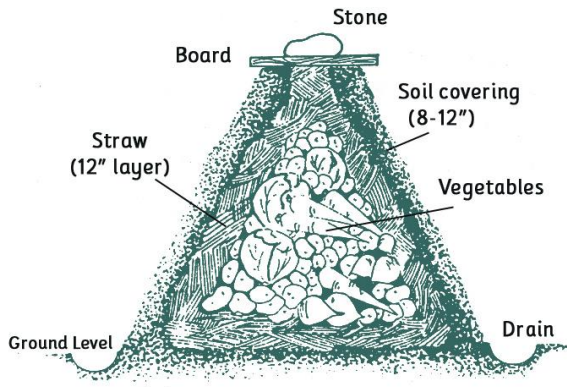
A common and very desirable way to preserve certain types of garden produce is through freezing. This method does not improve quality, but is fairly easy to do if one has access to a freezer and takes the time to package properly so that moisture is retained. Like other preservation methods, freezing prevents microorganisms from growing causing spoilage. One large advantage of freezing is that the nutritional quality remains relatively good, plus food can be kept for many months with little change in color. For certain soft produce, the texture may change considerably, though the importance of this is largely depends upon how the food will be subsequently used. Green peppers can be frozen but will become watery when brought back to room temperature. The texture will be very different from fresh produce, but the color will remain good.

Common Storage

The method used to preserve most of the produce generated by our ancestors is referred to as common storage. This involves storing harvested produce in a darkened, cold area. There are various ways where this can be done including leaving the produce in the ground, burying it in the ground in pits, storing in cellars or basements and storing in wooden crates or barrels located in cool areas like a garage or porch.

1. **In-ground Storage:** Some vegetables like carrot, beet, turnip, rutabaga, horseradish, salsify and parsnips can be left in the ground through the winter. They should either be mulched to prevent the crop from freezing or after the ground has frozen, mulched to keep the crop frozen. Alternate freezing and thawing will damage produce. This is why after the ground has frozen, you should mulch the crop by applying a 6 to 8-inch layer of hay, straw or leaves - enough to keep them frozen. Parsnips and horseradish may develop an undesirable bitter taste after a couple frosts. In this case, applying a mulch at the end of the season to prevent the ground from freezing so quickly may be a way of extending the taste quality.

2. **Pits:** Storing vegetables in an outdoor pit is also a good, but typically inconvenient, way to preserve produce. Burying in the earth allows for a controlled atmosphere because soil temperatures do not fluctuate - they remain cool compared to air temperatures. Pits, however, must be well drained and protected from rodents.



The most common way to form a pit is by sinking a barrel or galvanized can in the ground and leaving 2 or 3 inches of the rim above the ground so that moisture does not run into the container. Spread a layer of sand in the bottom of the can, then layer the produce in damp sand building toward the top. As the container becomes filled, cover with a lid and place a sufficient mound of straw or mulch over the top to provide insulation. A layer of plastic should also be applied so that moisture is kept out, Finish off with boards or bricks to prevent loss of the mulch layer due to wind or disturbance.

Similar results can be obtained by above-ground storage within a mound of insulating materials. This is done by forming a cone-shaped mound in which vegetables are layered. The mound can be composed of straw, hay or leaves, the bottom of the mound should be lined with a flexible type of hardware cloth to keep rodents out. Ventilation is also important to allow good air exchange. To do this, stakes can be used to form a tunnel down into the center of the mounded layers of vegetables. It should be open at the top of the mound and protected with a board to keep moisture and rodents out. The basic drawback to this method is that once the mound is open, it should not be resealed. A series of smaller mounds with a variety of vegetables in each can be a better method.

3. Indoor Storage: The most convenient place to store fruits and vegetables is inside the home. Typically, a second refrigerator is ideal for many types of produce if it is kept between 32 and 40 degrees. Some produce require higher storage temperatures for best preservation of quality and each crop should be considered individually (See Table).

Many older homes were built with unheated root cellars, cool pantries, enclosed porches or sheds specially built for vegetable or fruit storage. Today's modern basement is too warm to consider for storage, even with those crops that do best at higher temperatures like pumpkins, squash and sweet-potatoes. On the other hand, some areas can be modified for vegetable storage as long as temperatures between 32 and 60 degrees are possible. One might consider window wells insulated with hay or straw for storage of root crops like carrots, parsnips, horseradish, beets, turnips and winter radishes. Outside stairwells to basements can be used if space permits some insulation materials like bales of hay to line the space.

If no storage area is available, one can be constructed in the basement, but out of the direct effect of the central heating system. Insulated walls should be constructed to form a space that gives no more than about 140 to 150 cubic feet inside. This size will allow the cool atmosphere to be maintained more easily than larger spaces. The walls can be built from 2 x 4 studs and exterior plywood. The structure should be kept off of the floor by several inches and the base floor should be composed of wood. Keep fruits and vegetables off a concrete floor, which can encourage mildew formation.

A vapor barrier of polyethylene film or faced insulation should be included to keep condensation from collecting on the produce and interior walls. This means that all surfaces should be covered. Also desirable

is two insulated ports constructed in the walls. An elevated window can be opened to allow warm interior air to escape while a lower window located about a foot off the floor will encourage cool air to enter. In this way, some air circulation will be maintained.

Other Factors to Consider

- 1. A Clean Storage Space:** Always keep the storage area clean of debris and discard fruits and vegetables as soon as they begin to show signs of decay. Containers should be removed during the summer, washed and dried in the sun.
- 2. Monitor the Temperature:** Monitor temperatures to avoid produce being destroyed by any exposure to low or high temperatures, which can happen in extreme cases. Thermometers should be placed inside and outside the storage facility. Stored produce will give off heat during storage making it necessary to regulate temperatures by use of the ventilation windows. If the outside temperature is 25 degrees and the inside is 32 degrees with the ventilation windows closed, the temperature will begin to rise and windows should be opened to lower the temperatures. Close the ventilation windows when outside temperatures are above the desired storage temperatures. Because certain crops are more sensitive to low temperature injury, learn their freezing point. Most fall within a range of 29 to 31 degrees.
- 3. Regulate the Humidity:** Over time, vegetables and fruit will give up moisture and shrivel. Maintain proper moisture levels during storage by regulating humidity. This can be done by increasing the water in the air through humidifying or by using plastic bags and box liners for storage in individual crops. Humidification is simply taken care of by sprinkling water inside the storage area, but not directly on the produce. For root crops which lose moisture regardless of attempts to humidify with free water, placing them in plastic bags is perhaps the best way to keep them fresh. Plastic liners and bags should be ventilated by creating holes. Produce should never be sealed shut.
- 4. Handling Fruit and Vegetables:** Handle all produce with care to avoid wounds which become good sites for storage diseases. Pick all produce dry or let dry before storage. Pack produce in plastic or wooden baskets or boxes. Move the produce to the storage area when the field heat has been reduced. Harvesting in the early morning or cooling overnight outdoors will help.

Selected Crops & Storage Requirements

More vegetables than fruit can be stored; typically, they should not be mixed. When apples or pears are stored with certain vegetables, including onions or potatoes, they will adsorb odors given off by the vegetables. It, therefore, is best to store separately.

Vegetables

Certain vegetables will differ in their temperature, humidity and ventilation requirements for storage resulting in optimum quality and reduced incidence of disease or decay.

Beans and Peas: The best way to preserve legumes like beans and peas is to dry them. You can either pick the pods as soon as they are filled or a little earlier and spread them out to dry in a warm place, or pull the whole plants out of the ground and let them dry with pods intact over a frame. In either case, after the pods are dry they can be shelled and refrigerated at 0 degrees for several days then heated in an oven at 180 degrees for 15 minutes to kill storage pathogens and insects. Store in a moisture-proof container between 32 and 50 degrees F.

Cabbage: Harvest cabbage when the heads are firm. Heads can be stored for several months in plastic bags in outdoor pits. Another method is to harvest the whole plant and bury the heads in a soil mound with the roots sticking up. Cabbages can also be hung in the garage in well-ventilated plastic bags, however, do not put them in the basement because of the odor they give off.

Onions: Harvest onions when the tops have fallen over and the necks have shriveled. After removing the tops, place them in a spot to dry thoroughly and store in a well-ventilated area in hanging open-mesh bags or open crates. Prevent them from freezing. If they do become frozen, do not handle them because of their sensitivity to damage. Discard any which become watery and develop a soft rot.

Potatoes: Dig and cure early potatoes in moist air for 1 to 2 weeks at 60 to 75 degrees. This will harden small cracks and prevent decay over longer storage periods. Keep them stored at temperatures of 70 to 75 degrees. They will last for 4 to 6 weeks under these conditions. Late potatoes will last longer than early potatoes since outdoor temperatures are cool at harvest time. For late potatoes, cure by holding in moist air for 1 to 2 weeks. Store them at temperatures in the range of 35 to 40 degrees in the dark. Potatoes stored at 50 degrees or lower may become sweet. To correct for this flavor change, hold them at 70 degrees for a week before use.

Pumpkins and Squash: Pumpkins and squash can be kept for several months. Harvest them before the first frost leaving a piece of the stem intact. Cure for 10 days at 80 to 85 degrees in the field or near a furnace. This will harden the rind and heal surface wounds. Store pumpkins and squash in a dry place at 55 to 60 degrees. Above and below ideal temperature storage conditions will encourage decay or physical damage. Acorn squash do not need to be cured before storage. Place them in a dry area for 35 to 40 days at 45 to 50 degrees. If they begin to turn orange, the temperature is too high. Pumpkins and squash do not store well in cellars or pits.

Carrots, Beets, Turnips, Winter Radishes: Most root crops are best left in the garden until the nights are cold enough to warrant storage. Carrots left in the garden, if mulched well so that the ground does not freeze, can sometimes be kept until spring. Otherwise, dig root crops when the ground is dry, cut the tops back and wash the dirt off. Let them thoroughly dry, then store at 32 to 40 degrees under high humidity. Plastic bags work well for this. If stored in a cellar, you can fill a bin with moist sand and layer the root crops. Sand will prevent rodents from entering and create high humidities. Sphagnum moss or peat moss will also work in place of sand. Turnips should be stored separately from other vegetables because they will give off odors. They actually do much better if left in the garden as they can stand hard frosts.

Sweet potatoes: Sweet potatoes can be kept for long periods of time if kept in proper storage conditions. After they are dug with care, they should be cured by holding them for 10 to 20 days at temperatures of 75 to 85 degrees. If outside temperatures are not in this range, move them close the furnace. Maintain high humidity by wrapping the container in cloth or covering with paper. Once cured, move to a cooler place where the temperature is 55 to 60 degrees F. Do not store at or below 50 degrees as they are especially prone to cold injury. Outdoor pit storage is also not recommended because of the increased decay potential.

Fruits

If large quantities of fruit are stored, special storage facilities need to be provided since there is much more at stake. Most homes are not equipped for proper apple storage. Gardeners and homeowners should consider storing only small quantities of fruit for any length of time. Overall, fruit keeps best when moved to an area that is about 32 degrees. Refrigerators are typically warmer than this so the storage period is shorter.

Apples: The ability of apples to be stored for long periods largely depends upon variety, maturity and soundness at harvest along with storage temperature. Pick apples when they are of good color and mature, but firm. They should be free of insect damage and mechanical injuries.

The rate at which apples will soften after harvest is mostly a function of the variety. Apples stored at 32 degrees and in earthen cellars will keep the longest. However, apples can be stored many ways if protected from freezing and loss of moisture. This includes insulated boxes in sheds, in a barn mulched with hay or in straw-lined pits or barrels. Kitchen refrigerators work well for storing apples about 3 to 4 weeks. Most will take moisture out of the produce if not protected. Stored apples need 90 to 95% humidity. Try using liners or polyethylene to maintain the humidity. This is especially important for varieties such as Golden Delicious which are more prone to shriveling. Holes should be poked in the bags to release carbon dioxide and excess moisture. When a second refrigerator is used for storing apples, set it to just above freezing.

Keep in mind that most refrigerators are designed to compensate for the door opening several times each day. When left shut for long periods, the temperature may go below freezing.

For outdoor storage, when air temperatures reach 10 degrees, the threat of freezing can also be significant. Frozen produce will decay quickly once defrosted so prevent this by mulching, protecting or moving the produce when conditions become extreme.

Picking the best storing apples is critical if you expect them to last in excess of 3 to 4 months. Most early-ripening cultivars are not good storage apples. Good storing cultivars include: Golden Delicious (3-5 months), Jonathan (3-5 months), Red Delicious (3-5 months), Macintosh (3-4 months) and Cortland (3-4 months).

Pears: Pears never really become tree-ripened and for proper flavor and texture development must be ripened after harvest. Pears should be picked just as they have turned from deep green to pale green and are of full size, but firm. They can be stored with apples under similar conditions, but if stored too long they will breakdown without ripening. Bartlett and Kieffer pears should be ripened immediately at 60 to 65 degrees and canned or preserved.

Storage Requirements for Common Vegetables and Fruit

Produce	Temperature (degrees F)	Relative Humidity	Avg. Storage Life
Apples	32	90-95%	4-6 months
Beets	32	95%	1-3 months
Brussels Sprouts	32	90-95%	3-5 weeks
Cabbage	32	90-95%	3-4 months
Carrots	32	90-95%	4-6 months
Cauliflower	32	90-95%	2-4 weeks
Celeriac	32	90-95%	3-4 months
Chinese Cabbage	32	90-95%	1-2 months
Dry Beans	32-50	65-70%	1 year
Garlic	32	65-70%	6-7 months
Horseradish	30-32	90-95%	10-12 months
Kale	32	90-95%	10-14 days
Kohlrabi	32	90-95%	2-4 weeks
Leeks	32	90-95%	1-3 months
Onions	32	65-70%	5-8 months
Parsnips	32	90-95%	2-6 months
Pears	32	90-95%	1-2 months
Sweet Peppers	45-50	90-95%	8-10 days

Potatoes	38-40	90%	5-8 months
Pumpkins	50-55	70-75%	2-3 months
Rutabaga	32	90-95%	2-4 months
Salsify	32	90-95%	2-4 months
Sweet Potato	55-60	85-90%	4-6 months
Tomatoes (green)	55-60	85-90%	2-6 weeks
Turnips	32	90-95%	4-5 months