

# Understanding the Canning of Food

## Home Canning: Why Can Foods?

Canning can be a safe and economical way to preserve quality food at home. Canning favorite and special products to be enjoyed by family and friends is a fulfilling experience and a source of pride for many people.

The advantages of home canning are lost when you start with poor quality fresh foods; when jars fail to seal properly; when food spoils; and when flavors, texture, color and nutrients deteriorate using prolonged storage.

## How Canning Preserves Foods

The high percentage of water in most fresh foods makes them very perishable. They spoil or lose their quality for several reasons:

- growth of undesirable microorganisms - bacteria, molds, and yeasts,
- activity of food enzymes,
- reactions with oxygen,
- moisture loss.

Microorganisms live and multiply quickly on the surfaces of fresh food and on the inside of bruised, insect-damaged, and diseased food. Oxygen and enzymes are present throughout fresh food tissues. Proper canning practices include:

- carefully selecting and washing fresh food,
- peeling some fresh foods,
- hot packing many foods,
- adding acids (lemon juice or vinegar) to some foods,
- using acceptable jars and self-sealing lids,
- processing jars in a boiling-water or pressure canner for the correct period of time.

Collectively, these practices remove oxygen; destroy enzymes; prevent the growth of undesirable bacteria, yeasts, and molds; and help form a high vacuum in jars. Good vacuums form tight seals which keep liquid in and air and microorganisms out.

## Glossary of Terms

**Acid foods** - Foods which contain enough acid to result in a pH of 4.6 or lower. Includes all fruits except figs; most tomatoes; fermented and pickled vegetables; relishes; and jams, jellies, and marmalades. Acid foods may be processed in boiling water.

**Altitude** - The vertical elevation of a location above seal level.

**Ascorbic acid** - The chemical name for vitamin C. Lemon juice contains large quantities of ascorbic acid and is commonly used to prevent browning of peeled, light-colored fruits and vegetables.

**Bacteria** - A large group of one-celled microorganisms widely distributed in nature. See microorganism.

**Blancher** - A 6 to 8 quart lidded pot designed with a fitted perforated basket to hold food in boiling water, or with a fitted rack to steam foods. Useful for loosening skins on fruits to be peeled, or for heating foods to be hot packed.

**Boiling-water canner** - A large standard-sized lidded kettle with jar rack, designed for heat-processing 7 quarts or 8 to 9 pints in boiling water.

**Botulism** - An illness caused by eating toxin produced by growth of *Clostridium botulinum* bacteria in moist, low-acid food, containing less than 2 percent oxygen, and stored between 40 degrees and 120 degrees F. Proper heat processing destroys this bacterium in canned food. Freezer temperatures inhibit its growth in frozen food. Low moisture controls its growth in dried food. High oxygen controls its growth in fresh foods.

**Canning** - A method of preserving food in air-tight vacuum-sealed containers and heat processing sufficiently to enable storing the food at normal-home temperatures.

**Canning salt** - Also called pickling salt. It is regular table salt without the anticaking or iodine additives.

**Citric acid** - A form of acid that can be added to canned foods. It increases the acidity of low-acid foods and may improve the flavor and color.

**Cold pack** - Canning procedure in which jars are filled with raw food. "Raw pack" is the preferred term for describing this practice. "Cold pack" is often used incorrectly to refer to foods that are open-kettle canned or jars that are heat-processed in boiling water.

**Enzymes** - Proteins in food which accelerate many flavor, color, texture, and nutritional changes, especially when food is cut, sliced, crushed, bruised, and exposed to air. Proper blanching or hot-packing practices destroy enzymes and improve food quality.

**Exhausting** - Removal of air from within and around food and from jars and canners. Blanching exhausts it from live food tissues. Exhausting or venting of pressure canners is necessary to prevent a risk of botulism in low-acid canned foods.

**Fermentation** - Changes in food caused by intentional growth of bacteria, yeast, or mold. Native bacteria ferment natural sugars to lactic acid, a major flavoring and preservative in sauerkraut and in naturally fermented dills. Alcohol, vinegar, and some dairy products are also fermented foods.

**Headspace** - The unfilled space above food or liquid in jars. Allows for food expansion as jars are heated, and for forming vacuums as jars cool.

**Heat processing** - Treatment of jars with sufficient heat to enable storing food at normal home temperatures.

**Hermetic seal** - An absolutely airtight container seal which prevents reentry of air or microorganisms into packaged foods.

**Hot pack** - Heating of raw food in boiling water or steam and filling it hot into jars.

**Low-acid foods** - Foods which contain very little acid and have a pH above 4.6. The acidity in these foods is insufficient to prevent the growth of the bacterium *Clostridium botulinum*. Vegetables, some tomatoes, figs, all meats, fish, seafoods, and some dairy foods are low acid. To control all risks of botulism, jars of these foods must be (1) heat processed in a pressure canner, or (2) acidified to a pH of 4.6 or lower before processing in boiling water.

**Microorganisms** - Independent organisms of microscopic size, including bacteria, yeast, and mold. When alive in a suitable environment, they grow rapidly and may divide or reproduce every 10 to 30 minutes. Therefore, they reach high populations very quickly. Undesirable microorganisms cause disease and food spoilage. Microorganisms are sometimes intentionally added to ferment foods, make antibiotics, and for other reasons.

**Mold** - A fungus-type microorganism whose growth on food is usually visible and colorful. Molds may grow on many foods, including acid foods like jams and jellies and canned fruits. Recommended heat processing and sealing practices prevent their growth on these foods.

**Mycotoxins** - Toxins produced by the growth of some molds on foods.

**Open - Kettle canning** - A non-recommended canning method. Food is supposedly adequately heat processed in a covered kettle, and then filled hot and sealed in sterile jars. Foods canned this way have low vacuums or too much air, which permits rapid loss of quality in foods. Moreover these foods often spoil because they become recontaminated while the jars are being filled.

**Pasteurization** - Heating of a specific food enough to destroy the most heat-resistant pathogenic or disease-causing microorganism known to be associated with that food.

**pH** - A measure of acidity or alkalinity. Values range from 0 to 14. A food is neutral when its pH is 7.0: lower values are increasingly more acidic; higher values are increasingly more alkaline.

**Pickling** - The practice of adding enough vinegar or lemon juice to a low-acid food to lower its pH to 4.6 or lower. Properly pickled foods may be safely heat processed in boiling water.

**Pressure canner** - A specifically designed metal kettle with a lockable lid used for heat processing low-acid food. These canners have jar racks, one or more safety devices, systems for exhausting air, and a way to measure or control pressure. Canners with 20- to 21-quart capacity are common. The minimum volume of canner that can be used is 16-quart capacity, which will contain 7 quart jars. Use of pressure saucepans with less than 16-quart capacities is not recommended.

**Raw pack** - The practice of filling jars with raw, unheated food. Acceptable for canning low-acid foods, but allows more rapid quality losses in acid foods heat processed in boiling water.

**Spice bag** - A closeable fabric bag used to extract spice flavors in pickling solution.

**Style of pack** - Form of canned food, such as whole, sliced, piece, juice, or sauce. The term may also be used to reveal whether food is filled raw or hot into jars.

**Vacuum** - The state of negative pressure. Reflects how thoroughly air is removed from within a jar of processed food — the higher the vacuum, the less air left in the jar.

**Yeasts** - A group of microorganisms which reproduce by budding. They are used in fermenting some foods and in leavening breads.

## Ensuring Safe Canned Foods

Growth of the bacterium *Clostridium botulinum* in canned food may cause botulism — a deadly form of food poisoning. These bacteria exist either as spores or as vegetative cells. The spores, which are comparable to plant seeds, can survive harmlessly in soil and water for many years. When ideal conditions exist for growth, the spores produce vegetative cells which multiply rapidly and may produce a deadly toxin within 3 to 4 days of growth in an environment consisting of:

- a moist, low-acid food
- a temperature between 40°F and 120°F
- less than 2 percent oxygen

Botulinum spores are on most fresh food surfaces. Because they grow only in the absence of air, they are harmless on fresh foods.

Most bacteria, yeasts, and molds are difficult to remove from food surfaces. Washing fresh food reduces their numbers only slightly. Peeling root crops, underground stem crops, and tomatoes reduces their numbers greatly. Blanching also helps, but the vital controls are the method of canning and making sure the recommended research-based process times are used.

The processing times ensure destruction of the largest expected number of heat-resistant microorganisms in home-canned foods. Properly sterilized canned food will be free of spoilage if lids seal and jars are stored below 95°F. Storing jars at 50°F to 70°F enhances retention of quality.

## Food Acidity and Processing Methods

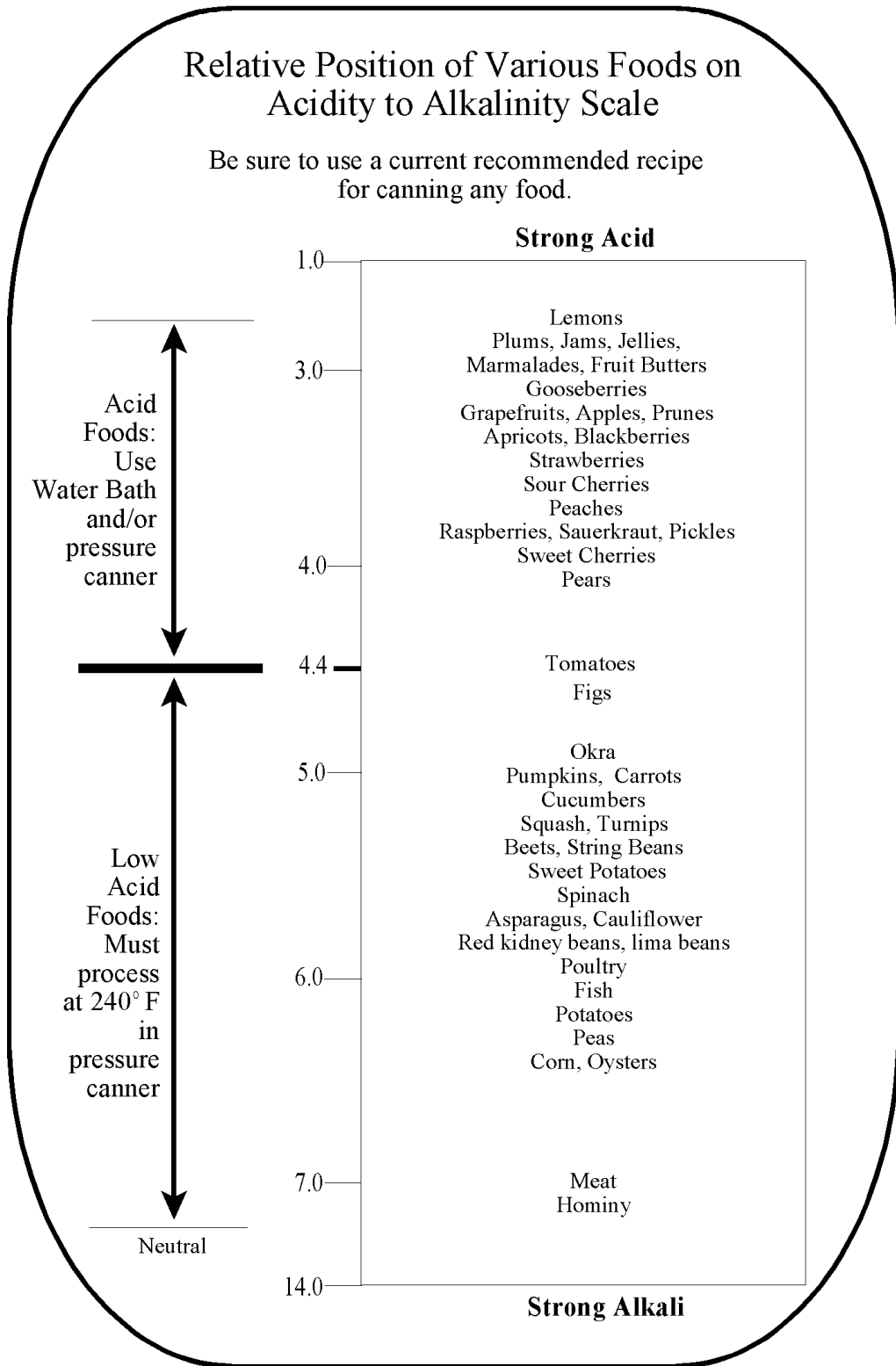
Whether food should be processed in a pressure canner or boiling-water canner to control botulinum bacteria depends on the acidity in the food ([Illustration 1](#)). Acidity may be natural, as in most fruits, or added, as in pickled food. Low-acid canned foods contain too little acidity to prevent the growth of these bacteria. Acid foods contain enough acidity to block their growth, or destroy them more rapidly when heated. The term “pH” is a measure of acidity; the lower its value, the more acid the food. The acidity level in foods can be increased by adding lemon juice, citric acid, or vinegar.

Low-acid foods have pH values higher than 4.6. They include red meats, seafood, poultry, milk, and all fresh vegetables except for most tomatoes. Most mixtures of low-acid and acid foods also have pH values above 4.6 unless their recipes include enough lemon juice, citric acid, or vinegar to make them acid foods. Acid foods have a pH of 4.6 or lower. They include fruits, pickles, sauerkraut, jams, jellies, marmalades, and fruit butters.

Although tomatoes usually are considered an acid food, some are now known to have pH values slightly above 4.6. Figs also have pH values slightly above 4.6. Therefore, if they are to be canned as acid foods, these products must be acidified to a pH of 4.6 or lower with lemon juice or citric acid. Properly acidified tomatoes and figs are acid foods and can be safely processed in a boiling-water canner.

Botulinum spores are very hard to destroy at boiling-water temperatures; the higher the canner temperature, the more easily they are destroyed. Therefore, all low-acid foods should be sterilized at temperatures of 240°F to 250°F, attainable with pressure canners operated at 10 to 15 PSIG. PSIG means pounds per square inch of pressure as measured by gauge. The more familiar “PSIG” designation is used hereafter in this publication. At temperatures of 240°F to 250°F, the time needed to destroy bacteria in low-acid canned food ranges from 20 to 100 minutes. The exact time depends on the kind of food being canned, the way it is packed into jars, and the size

of jars. The time needed to safely process low-acid foods in a boiling water canner ranges from 7 to 11 hours; the time needed to process acid foods in boiling water varies from 5 to 85 minutes.



**Illustration 1.**

## Process Adjustments at High Altitudes

Using the process time for canning food at seal level may result in spoilage if you live at altitudes of 1,000 feet or more. Water boils at lower temperatures as altitude increases. Lower boiling temperatures are less effective for killing bacteria. Increasing the process time or canner pressure compensates for lower boiling temperatures.

Therefore, when following canning directions, select the proper processing time or canner pressure for the altitude where you live. If you do not know the altitude, contact your closest airport.

### AIRPORT ELEVATIONS IN THE PHOENIX AREA

FAA: (602) 379-4226

Apache Junction. . . . .	1750 feet above mean sea level
Carefree. . . . .	2500
Cave Creek. . . . .	2500 (2200-2700 at Tonto National)
Chandler Municipal. . . . .	1242
Deer Valley. . . . .	1476
Falcon Field. . . . .	1392
Fountain Hills. . . . .	1520 (at Fountain), 3000 (at Golden Eagle Blvd.)
Glendale. . . . .	1066
Goodyear . . . . .	968
Scottsdale. . . . .	1508
Sky Harbor. . . . .	1133
Steller Airpark. . . . .	1175
Williams Gateway. . . . .	1383

## TABLE OF ELEVATIONS OF ARIZONA COMMUNITIES

Agua Caliente.....	516	Miami.....	3603
Ajo.....	1770	Mohawk.....	538
Apache Junction.....	1750	Mormon Lake.....	7000
Ashfork.....	5160	Nogales.....	3839
Benson.....	3523	Oracle.....	4522
Bisbee.....	5425	Parker.....	350
Bouse.....	1100	Payson.....	4906
Bowie.....	3756	Phoenix.....	1108
Buckeye.....	980	Sky Harbor.....	1133
Camelback.....	1249	Pinedale.....	6500
Canilla.....	5255	Prescott.....	5389
Casa Grande.....	1400	Quartzsite.....	871
Chandler.....	1213	Red Rock.....	1856
Chinle.....	5058	Roll.....	257
Clemenceau.....	3460	Roosevelt (Gila Co.).....	2275
Clifton.....	3465	Sacaton.....	1280
Cochise Stronghold.....	4950	St. Johns.....	5650
Douglas.....	3930	Salome.....	1775
Flagstaff.....	6907	San Carlos.....	2630
Florence.....	1500	Scottsdale Airport.....	1508
Fort Apache.....	5300	Seligman.....	5219
Fort Defiance.....	6950	Snowflake.....	5644
Ganado.....	6840	Springerville.....	6862
Gila Bend.....	737	Tempe.....	1159
Globe.....	3440	Thatcher.....	2800
Grand Canyon - south.....	6866	Tombstone.....	4580
Holbrook.....	5069	Tuba City.....	4500
Jerome.....	5250	Tucson.....	2423
Kingman.....	3266	Wellton.....	225
Litchfield park.....	1180	Wickenburg.....	2072
Maricopa.....	1186	Willcox.....	4200
Marinette.....	1150	Williams.....	6750
McNary.....	7251	Winslow.....	4848
Mesa.....	1245	Yuma Valley.....	110

## Temperature of Boiling Water at Various Elevations

One way to calibrate a metal stem thermometer is to compare the temperature it reads when placed in boiling water. The temperature of boiling water depends on the elevation where you live. Thermometers can also be calibrated to 32°F by placing it in a glass of ice with a small amount of water.

Sea Level	212°F
1000 Feet	210°F
2000 Feet	208.2°F
3000 Feet	206.2°F
4000 Feet	204.4°F
5000 Feet	202.6°F
6000 Feet	200.7°F
7000 Feet	198.7°F
8000 Feet	196.9°F
9000 Feet	195.6°F
10,000 Feet	194°F

## Equipment and Methods Not Recommended

Open-kettle canning and the processing of freshly filled jars in conventional ovens, microwave ovens, and dishwashers are not recommended, because these practices do not prevent all risks of spoilage. Steam canners are not recommended because processing times for use with current models have not been adequately researched. Because steam canners do not heat foods in the same manner as boiling-water canners, their use with boiling-water process times may result in spoilage. It is not recommended that pressure processes in excess of 15 PSI be applied when using new pressure canning equipment. So-called canning powders are useless as preservatives and do not replace the need for proper heat processing. Jars with wire bails and glass caps make attractive antiques or storage containers for dry food ingredients but are not recommended for use in canning. One-piece zinc porcelain-lined caps are also no longer recommended. Both glass and zinc caps use flat rubber rings for sealing jars, but too often fail to seal properly.

## Ensuring High-Quality Canned Food

Begin with good-quality fresh foods suitable for canning. Quality varies among varieties of fruits and vegetables. Examine food carefully for freshness and wholesomeness. Discard diseased and moldy food. Trim small diseased lesions or spots from food.

Can fruits and vegetables picked from your garden or purchased from nearby producers when the products are at their peak of quality-within 6 to 12 hours after harvest for most vegetables. For best quality, apricots, nectarines, peaches, pears, and plums should be ripened 1 or more days between harvest and canning. If you must delay the canning of other fresh produce, keep it in a shady, cool place.

Fresh home-slaughtered red meats and poultry should be chilled and canned without delay. Do not can meat from sickly or diseased animals. Ice fish and sea foods after harvest, eviscerate immediately and can them within 2 days.



## Maintaining Color and Flavor in Canned Food

To maintain good natural color and flavor in stored canned food, you must:

- Remove oxygen from food tissues and jars,
- Quickly destroy the food enzymes,
- Obtain high jar vacuums and airtight jar seals.

Follow these guidelines to ensure that your canned foods retain optimum colors and flavors during processing and storage:

- Use only high-quality foods which are at the proper maturity and are free of diseases and bruises.
- Use the hot-pack method, especially with acid foods to be processed in boiling water.
- Don't unnecessarily expose prepared foods to air. Can them as soon as possible.
- While preparing a canner load of jars, keep peeled, halved, quartered, sliced, or diced apples, apricots, nectarines, peaches, and pears in a solution of 3 grams (3,000 milligrams) ascorbic acid to 1 gallon of cold water. This procedure is also useful in maintaining the natural color of mushrooms and potatoes, and for preventing stem-end discoloration in cherries and grapes. You can get ascorbic acid in several forms:
  - **Pure powdered form** — seasonally available among canners' supplies in supermarkets. One level teaspoon of pure powder weighs about 3 grams. Use 1 teaspoon per gallon of water as a treatment solution.
  - **Vitamin C tablets** — economical and available year-round in many stores. Buy 500-milligram tablets; crush and dissolve six tablets per gallon of water as a treatment solution.
  - **Commercially prepared mixes of ascorbic and citric acid** — seasonally available among canners' supplies in supermarkets. Sometimes citric acid powder is sold in supermarkets, but it is less effective in controlling discoloration. If you choose to use these products, follow the manufacturer's directions.
- Fill hot foods into jars and adjust headspace as specified in recipes.
- Tighten screw bands securely, but if you are especially strong, not as tightly as possible.
- Process and cool jars.
- Store the jars in a relatively cool, dark place, preferably between 50°F and 70°F.
- Can no more food than you will use within a year.

## Advantages of Hot-packing

Many fresh foods contain from 10 percent to more than 30 percent air. How long canned food retains high quality depends on how much air is removed from food before jars are sealed.

Raw-packing is the practice of filling jars tightly with freshly prepared, but unheated food. Such foods, especially fruit, will float in the jars. The entrapped air in and around the food may cause discoloration within 2 to 3 months of storage. Raw-packing is more suitable for vegetables processed in a pressure canner.

Hot-packing is the practice of heating freshly prepared food to boiling, simmering it 2 to 5 minutes, and promptly filling jars loosely with the boiled food.

Whether food has been hot-packed or raw-packed, the juice, syrup, or water to be added to the foods should be heated to boiling before adding it to the jars. This practice helps to remove air from food tissues, shrinks food, helps keep the food from floating in the jars, increases the vacuum in sealed jars, and improves shelf life. Preshrinking food permits filling more food into each jar.

Hot-packing is the best way to remove air and is the preferred pack style for foods processed in a boiling-water canner. At first, the color of hot-packed foods may appear no better than that of raw-packed foods, but within a short storage period, both color and flavor of hot-packed foods will be superior.

## **Controlling Headspace**

The unfilled space above the food in a jar and below its lid is termed headspace. Directions for canning specify leaving  $\frac{1}{4}$ -inch for jams and jellies,  $\frac{1}{2}$ -inch for fruits and tomatoes to be processed in boiling water and from 1 - to  $1\frac{1}{4}$ -inches in low-acid foods to be processed in a pressure canner. This space is needed for expansion of food as jars are processed, and for forming vacuums in cooled jars. The extent of expansion is determined by the air content in the food and by the processing temperature. Air expands greatly when heated to high temperatures; the higher the temperature, the greater the expansion. Foods expand less than air when heated.

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