



# Cooking & Baking It Up!

HIGH ALTITUDE ADJUSTERS



College of Agriculture  
and Natural Resources  
Extension

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### **COOKING AND BAKING IT UP! ALTITUDE ADJUSTERS**

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### **UNIVERSITY OF WYOMING EXTENSION**

University of Wyoming Extension nutrition and food safety (NFS) educators serve every county and the Wind River Reservation and can provide guidance on high-altitude food preparation and preservation.

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Elevation Feet	Boiling Point (degrees Fahrenheit)
Sea level	212.0
3,000	206.7
5,000	203.2
7,000	199.8
8,000	198.1
<p>According to the U.S. Department of Agriculture, most western states (Alaska, Arizona, California, Colorado, Idaho, Montana, Nebraska, New Mexico, Nevada, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming) lie entirely or in part at high altitude. <b>ALL of Wyoming is above 3,000 feet.</b></p>	

Altitudes in Wyoming		
County or Entity	Town or Community	Altitude
<b>3,000 feet</b>		
Sheridan	Sheridan	3745
Big Horn	Basin	3870
Washakie	Worland	4061
Goshen	Torrington	4104
Hot Springs	Thermopolis	4326
Weston	Newcastle	4334
Campbell	Gillette	4544
Johnson	Buffalo	4645
Platte	Wheatland	4733
Crook	Sundance	4750
Converse	Douglas	4815
<b>5,000 feet</b>		
Niobrara	Lusk	5015
Park	Cody	5016
Natrona	Casper	5123
Fremont	Lander	5357
Wind River	Ethete	5354
Reservation	Ft. Washakie	5571
Laramie	Cheyenne	6062
Sweetwater	Green River	6100
Teton	Jackson	6209
Uinta	Evanston	6748
Carbon	Rawlins	6755
Lincoln	Kemmerer	6927
<b>7,000 feet</b>		
Albany	Laramie	7165
Sublette	Pinedale	7175
Yellowstone National Park	Grant Village	7825

# COOKING AND BAKING AT HIGH ALTITUDES

You may wonder why potatoes take longer to cook, cookies spread too much, or cakes keep falling. In high country, a three-minute egg may not be done in three minutes, and a bowl of soup may come to a boil quickly but not be especially hot. It takes longer to cook vegetables, dried beans, pot roasts, stews or anything in liquid.

Since most recipes are created for sea level, success at high altitudes may require adjustments in time, temperature, or ingredients. On the other hand, even with adjustments, some sea-level recipes may never produce the same results at higher altitudes.

High altitude means lower air pressure, which decreases water's boiling temperature so liquids evaporate faster. This affects range-top cooking, slow cooking, candy making, canning, and the internal structure of baked goods.

## There are no easy formulas

Sometimes it takes repeated trials, making one change at a time to arrive at recipe success. If you are not happy with the finished texture or appearance, try one change at a time, making the smallest adjustment first and working up to the largest until you like the results. Even with altitude adjustments, the end product may never be the same as if prepared at sea level. With that said, do not assume your sea-level recipe will fail. Try it first. It may need no modification or only a little. The following altitude adjusters provide a place to start.

### General adjustments

Adjustment	3,000 feet	5,000 feet	7,000 feet
Increase liquid. For each cup add:	1–2 tablespoons	2–4 tablespoons	3–4 tablespoons
Liquids evaporate faster in all cooking processes.			
Reduce baking powder. For each teaspoon decrease:	1/8 teaspoon	1/8–1/4 teaspoon	1/4 teaspoon
Prevents excess rising that stretches cell structure, producing coarse, irregular texture causes dough to sink in the center results in low volume.			

## General adjustments

Adjustment	3,000 feet	5,000 feet	7,000 feet
Reduce sugar. For each cup decrease:	0–1 tablespoon	0–2 tablespoons	1–3 tablespoons
Because of faster liquid evaporation, sugar solutions become more concentrated, affecting the texture.			
Increase flour. For each cup add:	0–1 tablespoon	0–2 tablespoons	2–4 tablespoons
Flour strengthens the structure of baked goods.			
Increase oven temperature	15–25°F	15–25°F	15–25°F
Helps set the batter before the cells expand too much. Cookies may not need a temperature increase.			

### How lower air pressure affects baking

Lower air pressure affects baked goods two main ways: they lose moisture more quickly and rise more easily.

Quicker evaporation can make baked goods more prone to sticking as sugar becomes more concentrated. Some cakes won't set, or by the time they do, they are dry and crumbly.

Leavening gases in breads and cakes expand more rapidly. Leavening occurs faster, and gas bubbles tend to group together into large, irregular pockets in a batter or dough. This can create a coarse-textured cake. Also, the pressure within rising batter can build, stretching cell walls and causing them to burst. The collapse of cell walls means the cake falls.

Problems usually can be corrected by adjusting baking temperature and one or more key ingredient, including baking powder, soda, sugar, liquid, or fat. Make only one adjustment at a time.

In general, to reinforce cell walls, decrease sugar and fat (the tenderizers) and increase eggs and flour (the strengtheners). Reducing leavening agents (baking powder, baking soda, etc.) can relieve pressure within the cells.

For cake mixes and other mixes for baked goods, check the package or manufacturer's website for specific directions.

# CAKES

## Rich cakes

Rich cakes are those made with butter, shortening, or oil. They include shortened cakes and chiffon cakes, which are made with oil and egg whites. Fat weakens the cell structure so rich cakes may need one or two tablespoons less fat per cup than called for in the recipe. Eggs strengthen cell structure. Adding an egg or using a larger egg may prevent a rich cake from falling.

## Shortened cakes

Shortened cakes, also known as butter cakes or cream cakes, contain solid fat and a leavening agent, such as baking powder or soda. Their texture should be tender, moist, and velvety. Above 3,000 feet, lower atmospheric pressure may cause the cake to rise too quickly. The cell structure may overexpand before the cake “sets.” The batter may even rise so high it spills over the top of the pan.

At best, the cake may have a coarse texture. At worst, cell walls may overexpand and break, causing the cake to fall. These problems can usually be avoided by adjusting baking temperature and one or more key ingredient: baking powder or soda, sugar, liquid, and fat.

## Foam cakes

Light and fluffy foam cakes contain no fat and are leavened by air and steam. They include angel food cakes, which are made with egg whites, and sponge cakes, which are made with whole eggs.

Although the leavening agent is mostly air, it is important not to beat too much air into the eggs. Overbeating expands air cells too much and causes the cake to fall. For angel food cakes, beat the egg whites only until they form a peak that falls over, not until they are stiff and dry.

Using less sugar, more flour, and a higher baking temperature also helps strengthen the cell structure of foam cakes.

### High-altitude tips

- All steps – from selecting ingredients to choosing the baking temperature – are more critical for baking a cake at altitude.
- Select ingredients carefully. Avoid substitutions such as using all-purpose flour for cake flour.
- Measure accurately, and follow the mixing directions carefully.
- Use the exact pan size called for in the recipe.





# COOKIES

Cookie recipes typically work well at altitudes below 7,000 feet, but they take longer to bake. Even cookie recipes that give acceptable results at high altitudes may be improved by increasing the baking temperature by 15-25°F. If oven temperature is increased, check for doneness early and reduce baking time if necessary. If temperature is not increased, increase the baking time.

Make a test cookie. Some adjustments can be made to the remaining cookie dough.

Cookies baked at high altitude may spread out too thin or develop a tough or even rock-hard texture. Try one or more of these altitude adjustments.

Problem	Adjustments
<b>Cookies</b>	
Dry texture	Increase liquid by 1 to 2 tablespoons  If the recipe calls for oatmeal, use quick oats rather than old fashioned oats  Try extra-large eggs for added moisture and structure
Tough texture	Reduce liquid
Does not spread enough	Increase butter or shortening 2 tablespoons to ¼ cup  Decrease sugar slightly (amount depends on size of batch and other ingredients)
Spreads too much	Decrease fat by ⅛ to ¼  Increase flour, starting with 1 or 2 tablespoons  Place cookie dough on a cool baking sheet rather than one that is hot from a previous batch  Use an electric mixer to cream butter and sugar. This can help reduce spreading by whipping air into the butter. Beat the butter and sugar just long enough to blend well, which should take no more than 30 seconds on low-speed.
Soapy aftertaste	Reduce baking soda or baking powder by ⅛ teaspoon

Problem	Adjustments
<b>Bars or brownies</b>	
Overbaked sides, underbaked center	Decrease oven temperature by 25°F Increase flour 1 tablespoon to ⅓ cup
Sunken center	Increase bake time up to 10 minutes
Gummy texture	Decrease oil 1 tablespoon to ½ cup
Greasy appearance or touch	Increase flour 1 tablespoon to ⅓ cup



# QUICK BREADS

Quick bread is the term for muffins, coffee cakes, scones, biscuits, and cake-like breads (such as banana bread) that typically rise without yeast. Muffins and breads should be delicate with a moist crumb. Biscuits should have a flaky, layered texture.

Because of quick breads' firmer structure, most recipes can be prepared at high altitudes without change or with a slight decrease in baking powder. On the other hand, if quick breads come out with a porous, sugary crust, a coarse, gummy or oily texture, or a low volume in relation to weight, altitude is likely the problem.

Using less baking powder or soda usually improves texture and prevents a bitter, soapy, or alkaline aftertaste. It's generally recommended to reduce baking powder or soda by one-eighth per teaspoon and to reduce sugar and fat by two to four tablespoons for each cup in the recipe. One teaspoon of baking powder or one-half teaspoon of baking soda per cup of flour is usually enough for quick breads at 5,000 feet.

## High-altitude tips

- Don't overmix batter. This can cause poor shape, tunnels, or poor texture.
- Quick breads baked in loaf pans may crust over and start to brown on top before the batter underneath begins to set. To prevent this, cover the pan loosely with foil after half the baking time or substitute a tube pan for a loaf pan.

Problem	Adjustments
<b>Quick breads</b>	
Overexpansion during baking	Decrease baking soda or baking powder $\frac{1}{8}$ to $\frac{1}{4}$ teaspoon Decrease sugar 1 to 2 tablespoons Decrease fat 2 tablespoons to $\frac{1}{4}$ cup
Partially collapsed, sticky/tacky to the touch, or dipped in center	Increase water 1 to 4 tablespoons Increase flour 2 to 4 tablespoons Increase oven temperature 15°F to 25°F

Problem	Adjustments
<b>Muffins, biscuits and scones, including quick bread mixes</b>	
Dry texture	Increase liquid by 1 to 2 tablespoons or according to package
Flat tops that flow together	Decrease baking soda or baking powder $\frac{1}{8}$ teaspoon Decrease sugar slightly Increase number of muffins as batter has more volume Increase flour, starting with 1 tablespoon or according to package
Overbrowning	Decrease bake time by 1 to 3 minutes



# YEAST BREADS

For baking yeast breads in high country, you may need to adjust for these two high-altitude lows.

## Low humidity

In the dry climate, flour tends to be drier and absorb more liquid. A little less flour or slightly more liquid may be needed to maintain the proper dough consistency. There is no hard and fast rule because changes in humidity affect the flour's dryness and the amount needed in the same recipe on different days. A rule of thumb, however, is to add one-third of the flour at a time until you have a soft dough that pulls away from the sides of the bowl.

A lack of humidity can also dry the rising dough and cause a crust to form. To prevent this, cover the dough with a damp cloth or place it in a warm, closed cupboard with a pan of hot, steaming water.

## Low air pressure

Yeast bread doughs double in size faster at high altitudes because the lower air pressure causes leavening gases to expand more quickly. This faster rising speeds the bread making process but also causes problems.

Sufficient rising time is required for the development of good flavor and a light texture. Using less yeast or letting the dough rise twice before shaping it into loaves or rolls usually allows enough time for good flavor. Allow the dough to rise only until double its original size before punching it down or baking. Letting the dough rise too long may cause over-fermentation and a coarse, open-textured bread with a yeast-like flavor.

At altitudes over 3,500 feet, increase baking temperature by 25°F. Most sea-level recipes require baking temperatures between 375°F and 400°F, so the best higher-altitude baking temperatures are between 400°F and 425°F. The higher temperature quickly sets the cell walls and stops further rising, preventing the dough from becoming too light.

A simple method to test yeast dough is to quickly press the tip of your finger into the center. If a dent remains in the dough, it is ready to be punched down.

# PUDDINGS AND PIES

One of the myths of high-altitude baking is that pies need no adjustment. That is not exactly true, though pies are easier to adjust than cakes.

Above 5,000 feet, temperatures in the top of a double boiler are not high enough for complete thickening of puddings and cream pie fillings thickened with cornstarch. Use direct heat instead, carefully controlling the temperature and stirring to prevent scorching.

Baking pie fillings all the way through takes longer at high altitude. But be careful not to overcook puddings and pie fillings, as this can cause the starch mixture to break down and become watery.

<b>Problem</b>	<b>Adjustments</b>
<b>Pie crust</b>	
Dry texture	Increase liquid by one tablespoon of cold water at a time until desired consistency
Tough crust	Decrease liquid
Soggy crust	Bake in the lower third of the oven, closer to the heating element
Crust dark before fruit filling completely cooked	Cover pie loosely with foil partway through baking
<b>Puddings and cream pie fillings</b>	
Not thickened to proper consistency	Use direct heat instead of a double boiler
Watery	Do not overcook

# RANGE-TOP COOKING

As altitude increases, water comes to a boil more quickly but at a lower boiling point. Foods take longer to cook in liquids. Don't increase the heat, as that will only cause the liquid to boil away faster. Covering foods during cooking will help retain moisture. Liquids evaporate faster, so you may need to increase the cooking liquids.

Variations in food size and ripeness make it impossible to recommend additional cooking times, but in general, cooking times increase 4 to 10 percent per 1,000 feet, depending on the food. Use a meat thermometer to check for doneness.

Simmered or braised meat and poultry are especially prone to drying and may take as much 25 percent longer to cook at 5,000 feet.

<b>Problem</b>	<b>Adjustments</b>
<b>Meats (simmer/braise)</b>	
Dry	Increase cooking liquid
<b>Pasta and rice</b>	
Not done—crunchy	Increase cooking time 3-5 minutes or until soft Increase cooking liquid if necessary
<b>Soups, stews and sauces</b>	
Liquid evaporates faster	Add water to achieve desired consistency. For sauces, start with 1 to 2 Tablespoons; for soups and stews, the amount needed could be up to 1 cup.

## BOILED EGGS

Perfect soft-boiled eggs have firm, custard-like whites and warm, runny yolks. The traditional 3-minute egg may take 5 to 6 minutes. Hard-boiled eggs take even longer.

Place eggs in a saucepan large enough to hold them in a single layer. Add cold water to cover eggs by 1 inch. Heat on high just to boiling. Reduce heat and simmer for 5 minutes. Cover pan and remove from burner. Let large eggs stand 15 minutes or 20 minutes for extra-large eggs.

## DEEP FRYING

The lower boiling point at high altitudes also affects deep frying. To prevent fried foods from over-browning on the outside and under-cooking on the inside, lower the temperature of the fat at high altitudes. The temperature varies according to the food and elevation. In general, decrease the frying temperature about 3°F for each 1,000 feet increase in elevation. For example, to fry doughnuts at 5,000 feet, adjust a sea-level recipe for frying doughnuts at 370°F down 15°F and fry them at 355°F ( $5,000 \div 1,000 = 5 \times 3^\circ\text{F} = 15^\circ\text{F}$ ).



# SLOW COOKERS AND PRESSURE COOKERS

## Slow cooker

In a slow cooker, water and steam are conducted through the food. The lower boiling point at altitude means the slow cooker simmers at a lower temperature, which makes it important to ensure food reaches a high enough temperature (165°F) to destroy bacteria. Use a meat thermometer to check temperature of cooked food. If using cornstarch or flour to thicken sauce or gravy, increase the liquid. Turn cooker back to high after adding ingredients (such as for gravy or sauce) near end of recipe.

Problem	Adjustments
Does not reach and maintain high temperature for food safety	Defrost frozen meat, poultry and vegetables before cooking Cook food on high for the first hour
Longer cooking time	Place aluminum foil over the pot before putting on the lid to reflect heat back into the food Avoid removing lid

## Pressure cooker

A pressure cooker is great for cooking at high altitudes because it speeds up cooking and eliminates the effects of low air pressure. You control the



atmospheric pressure in the pot. By increasing pressure, the temperature at which water boils is raised, and foods cook more quickly and thoroughly.

Recipes may require adjustment. For dial-gauge pressure cookers with a maximum weighted gauge of 15 pounds, increase cooking time. Add one to two minutes for most vegetables at 5,000 feet and up. Very dense vegetables, such as beets, whole potatoes, and sweet potatoes, may require an additional five minutes.

If food is undercooked after pressure is released, simmer uncovered until done.

More cooking liquid may also be needed to compensate for increased altitude and cooking time.

<b>Pressure cooker time and liquid adjustments</b>		
Altitude, feet	Increase cooking time per 20 minutes	Increase liquid per 16 oz. (2 cups)
3,000	1 minute	1 Tablespoon
4,000	2 minutes	1½ Tablespoon
5,000	3 minutes	2 Tablespoons or ⅛ cup
6,000	4 minutes	3 Tablespoons
7,000	5 minutes	4 Tablespoons or ¼ cup
8,000	6 minutes	5 Tablespoons

<b>Problem</b>	<b>Adjustments</b>
Longer cooking time	Defrost frozen meat, poultry and vegetables before cooking
Does not reach pressure	Allow more time to cook
Liquid evaporates	Increase liquid Once the desired pressure is reached, adjust burner to maintain a steady pressure at, or slightly above, the correct gauge pressure

# CANDIES, SYRUPS AND JELLIES

Boiling causes loss of moisture through evaporation, adjusting for evaporation is the key to making syrups, candies and jellies.

The lower the boiling point, the sooner moisture evaporation begins. At high altitudes, when sugar mixtures, such as candies, syrups, and jellies, are cooked at the temperature for sea-level recipes, the faster loss of liquid can cause the mixture to become too concentrated. Depending on the type of sugar mixture, the texture may become sugary or hard.

To adjust for high altitude, cook the syrup at a lower temperature than indicated in the sea-level recipe.

## How to calculate a final candy temperature

- 1 Bring a pan of water to a rapid boil.
- 2 Read the thermometer to find the boiling point of water at your altitude. Be careful not to let the bulb slip out of the water or touch the edge or bottom of the pan.
- 3 Subtract the boiling point of water at your altitude from the boiling point of water at sea level (212°F).
- 4 Subtract the temperature reached in Step 3 from the final temperature in the recipe to get the final temperature for your recipe at your altitude. When the sugar mixture reaches this temperature, remove the pan from the stove.

For example, if the boiling point of water at your altitude is 192°F, subtract 192°F from 212°F (boiling point of water at sea level) to find the temperature adjustment. Subtract this number from the finish temperature in the recipe.

## Cold water test

The cold water test works well at all altitudes. Your recipe may advise cooking until ½ teaspoon of the syrup dropped into cold water forms a soft, firm or hard ball when removed. If the syrup separates into threads that are hard but not brittle when dropped in the cold water, it has reached the “soft crack” stage. If these threads are brittle as well as hard, it has reached the

“hard crack” stage. Be sure to remove the pan from heat while testing, so candy doesn’t overcook.

### Sheet test

For jellies, the sheet test with a metal spoon is reliable at all altitudes. Dip a cool metal spoon into the boiling jelly mixture. Raise the spoon at least a foot above the pan, away from the steam, and turn the spoon so the syrup runs off the side. If the syrup forms two drops that flow together and fall off the spoon as one sheet, the jelly should be done.



*Assorted jams by Mary Kay Wardlaw*

# CANNING

Lower atmospheric pressure and lower boiling temperatures make altitude adjustments essential for home canning. For boiling-water canning, processing times must be increased. For pressure canning, the pressure must be increased.

All home-canned foods should be canned according to U.S. Department of Agriculture (USDA) or USDA-endorsed recommendations. Refer to the Complete Guide to Home Canning at [www.uga.edu/nchfp/publications/publications\\_usda.html](http://www.uga.edu/nchfp/publications/publications_usda.html).

If using “Grandma’s” recipes, note the USDA changed processing times for many foods in 1988. Compare old recipes to newer formulations and tested recipes. Some might have changed in response to research conducted on home canning.

## High-acid foods

High-acid foods (pH of 4.6 or lower), such as peaches, pears, pickles, tomatoes, apples, and other fruit, can be processed in a boiling water canner. Boiling water processing is essential for safely canning pickles, fruits, and soft spreads, such as jams and jellies.

### Adjustments for boiling water processing

Altitude (feet)	Increased boiling time required
3,000	5 minutes
3,001-6,000	10 minutes
6,001-8,000	15 minutes
8,001-10,000	20 minutes

Source: [www.freshpreserving.com/altitude-adjusting.html](http://www.freshpreserving.com/altitude-adjusting.html)

## Low-acid foods

Low-acid foods (pH greater than 4.6 and less than 7.0) should be processed using a pressure canner. These include meats, poultry, most vegetables and combination foods, such as stews and meat sauces or tomatoes with onions.

Even hot peppers are low-acid and require pressure-processing using a tested recipe to prevent bacterial growth and food spoilage. The latest recommendations for some lower-acid tomato varieties include processing in a boiling water bath for up to 100 minutes.

If using a dial gauge at high altitudes, increase the pressure in the canner by 1 pound of pressure for each 2,000 feet above sea level. With a weighted gauge, use the 15-pound weight for all altitudes above 1,000 feet. You do not need to add additional processing time if the pressure of the canner is adequately adjusted.

<b>Adjustments for pressure canning</b>		
<b>Altitude, feet</b>	<b>Pressure, lbs</b>	
	Weighted Gauge	Dial Gauge
Sea level	10	11
3,000 ft.	15	12
5,000 ft.	15	13
7,000 ft.	15	14
9,000 ft.	15	15

Source: USDA Food Safety and Inspection Service

### **Canning safety**

- Use recipes with current processing times established by the USDA. Apply appropriate altitude adjusters.
- Do not add or change ingredients or proportions in home canning recipes. This could compromise food safety.
- Use standard canning jars made of tempered glass. Do not use commercial jars, such as mayonnaise jars. These break more easily and have a narrower sealing surface that prevents a good seal.
- To prevent the risk of botulism, boil low-acid home-canned foods, such as meats and vegetables, before eating. At 3,000 feet, boil for 12 minutes. Add an additional minute for each additional 1,000 feet elevation. (For example, at 5,000 feet, boil for 14 minutes. At 7,000 feet, boil for 16 minutes).
- Get your pressure canner tested annually. Your local UW Extension nutrition and food safety educator can test the dial-type gauge on your pressure canner to ensure it is operating properly. The test is free. Call ahead for an appointment to bring in your canner lid.

For resources on preserving specific types of food in Wyoming, see <http://bit.ly/uwfoodpreserve>. The series covers getting started, jellies, fruit, meat, pickles, tomatoes, vegetables, wild berries, and more.

# FOOD SAFETY FUNDAMENTALS

While taste and nutrition are important when preparing food, food safety must be front and center. Foodborne illnesses can be serious—even life-threatening—but you can prevent most cases by following a few simple practices.

**Wash your hands!** Washing hands greatly reduces the risk of illness. Nothing replaces washing with soap and warm water, but if soap and water are not available, use an alcohol-based hand sanitizer. Always wash your hands after using the restroom or handling potentially hazardous foods like meat or eggs. The bottom line: wash your hands before, during, and after handling food products.

**Keep hot foods hot and cold foods cold.** Bacteria multiply quickly under the right conditions. Their numbers can double every 15 minutes! Potentially hazardous foods should not remain in the danger zone (40°–140°F) longer than two hours. Although the maximum time food should be left out for serving is two hours, when the weather is hot and temperatures are higher than 90°F, perishable food must be refrigerated or thrown out after only one hour.

**Separate – don't cross-contaminate.** Use a separate cutting board for raw foods like meat, poultry, and fish and another for cooked foods, salads and ready-to-eat foods like salads. Use a clean plate and utensils to serve foods. If you transport meat in a cooler, make sure it is well wrapped and use plenty of ice. Coolers should be washed and sanitized regularly.

**Know safe temperatures.** Different types of meat need to be cooked to different temperatures to be safe to eat. Because you can't tell if meat is done by looking at it, use a calibrated thermometer. For correct temperatures and how to use a meat thermometer, visit [www.IsItDoneYet.gov](http://www.IsItDoneYet.gov).

**Wash your produce** – even fruits like cantaloupe and watermelon. If a melon hasn't been properly washed, a knife can carry germs from the outside to the inner part that will be eaten. Fresh water and a good scrub brush will clean these foods.



## SOURCES

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*Bread & Butter Pickles by Cathy Shuster*