

Increasing baking temperature by 15 to 25 degrees can also help “set” the batter before the cells formed by the leavening gas expand too much. Other factors that can weaken cell structure are excess sugar and fat. Greater evaporation of water at high altitude can cause sugar in recipes to become more highly concentrated. Compensate by slightly decreasing sugar and increasing liquid in a recipe. In making rich cakes at high altitudes, it may help to reduce butter or shortening by 1 or 2 tablespoons. Also, increasing the amount of egg can strengthen cell structure and may prevent the too-rich cake from falling. Only repeated experiments with each recipe can give the most successful proportions to use. Table 3 is a helpful starting point. Try the smaller adjustments first, as this may be all that is needed.

Angel Food and Sponge Cakes

The leavening gas for these is largely air. Beat egg whites only until they form soft, shiny peaks that droop slightly – not stiff and dry, which will cause collapse of cells. Strengthen cell structure by using less sugar and more flour, and a higher baking temperature.

Cake Mixes

Adjustments usually take the form of strengthening the cell walls of the cake by adding all-purpose flour and liquid. Suggestions for high-altitude adjustments are provided on most cake mix boxes.

Table 3: Cake-recipe adjustment guide for high altitude.			
Adjustment	3,500 to 6,500 ft.	6,500 to 8,500 ft.	8,500 to 10,000 ft.
Reduce baking powder, for each tsp., decrease:	1/8 tsp.	1/8 - 1/4 tsp.	1/4 tsp.
Reduce sugar, for each cup, decrease:	0-1 Tbsp.	0-2 Tbsp.	1-3 Tbsp.
Increase liquid, for each cup, add:	1-2 Tbsp.	2-4 Tbsp.	3-4 Tbsp.

Cookies

Many cookie recipes contain a higher proportion of sugar and fat than necessary, even at low altitudes. Although many sea-level recipes yield acceptable results at high altitudes, they often can be improved by a slight

increase in baking temperature, a slight decrease in baking powder or soda, a slight decrease in fat or sugar, and/or a slight increase in liquid ingredients. **Tip:** Use only regular cookie sheets (no double layer, insulated) to allow adequate heat penetration.

Biscuits, Muffins and Quick Breads

Quick breads vary from muffin-like to cake-like in cell structure. Although the cell structure of biscuits and muffin-type quick breads is firm enough to withstand the increased internal pressure at high altitudes without adjustment, a bitter or alkaline flavor may result from inadequate neutralization of baking soda or powder. If this occurs, reducing the baking soda or powder slightly will usually improve results.

Quick breads with a cake-like texture are more delicately balanced and usually can be improved at high altitudes by following the adjustment recommendations given for cakes.



Pie Crusts

Although not generally affected by altitude, slightly more liquid may improve results. To prevent a soggy crust, it can help to bake the pie in the lower third of the oven, closer to the heating element.

Practical Baking Tips

Do not assume that your sea level recipe will fail. Try it first. It may need little or no modification. That said, the higher the elevation, general rules of thumb may not apply. Make one modification at a time to know what works best.

For improved nutrition and a heartier texture, substitute whole wheat pastry flour for half the all-purpose flour called for in cookies, cakes, and pies.

Food tends to taste blander at higher elevations, so at 7,000 and above, add extra spices to enhance flavors of baked goods.

Take non-stick precautions seriously! At altitude, baked goods have a higher tendency to stick to the pans.

CSU Extension Resources

For purchase from the Resource Center

High Altitude Baking booklet; 32 pgs. Recipes tested for altitudes between 3,000-7,000 feet.

High Altitude Baking-2nd edition; 2005. Editor P. Kendall, Colorado State University Extension. Collection of 200 delicious recipes and tips for perfect high altitude cookies, cakes, breads and more.

www.csuextstore.com/pc/home.asp

Colorado Farm to Table Food Safety website offers further information on high altitude food preparation and preservation, gluten-free baking and altitude-tested recipes.

<http://farmtotable.colostate.edu>

Contact your local CSU Extension county office regarding food safety classes, food preservation workshops, pressure canner gauge testing, Master Food Safety Advisor volunteer program, cottage food business product support and more!

www.ext.colostate.edu

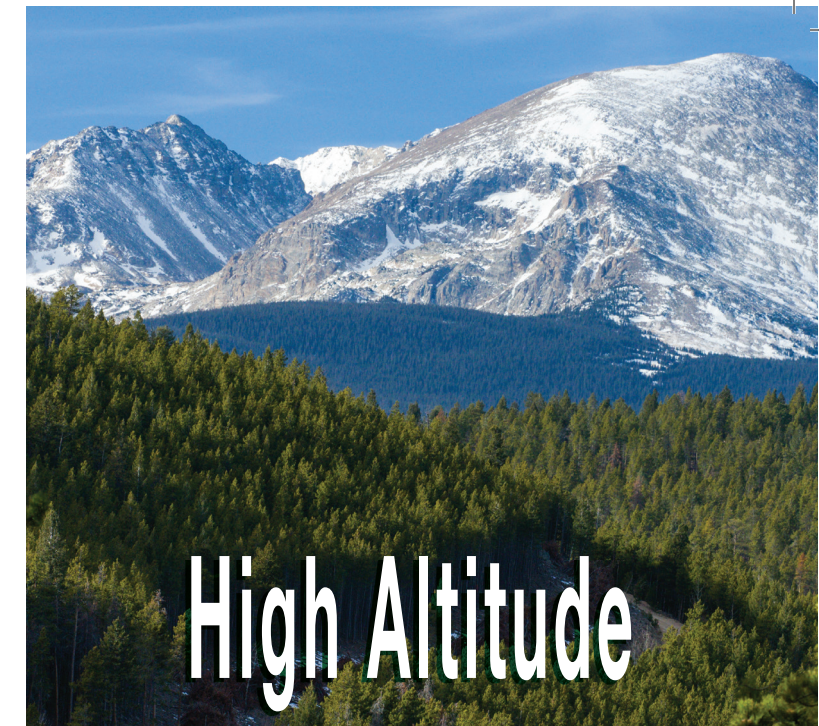
Additional Resources

USDA *High Altitude Cooking & Food Safety*: www.fsis.usda.gov/PDF/High_Altitude_Cooking_and_Food_Safety.pdf

Developed by Patricia Kendall, Colorado State University Extension, food science and human nutrition specialist and professor; revised 2013 by CSU Extension.

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High Altitude

Food Preparation Guide



Colorado State University

Extension

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Newcomers to Colorado or those traveling to the mountains are often surprised to find that favorite recipes made perfectly at sea level may fail to produce expected results when made at higher elevation. Whether boiling eggs, preparing a roast or baking cookies, general suggestions for food preparation at altitude are listed here-in. More complex foods may require additional modifications. Researchers with Colorado State University's Extension and Department of Food Science and Human Nutrition have a long tradition of baking research and development of altitude-tested recipes. For specific altitude-tested recipes and additional information on preparing foods at altitude, please see the Resource section listed in this publication.

At altitudes above 3,000 feet, preparation of food may require changes in time, temperature or recipe, because of lower atmospheric pressure due to a thinner blanket of air above. At sea level, atmospheric pressure is 14.7 pounds per square inch (psi), at 5,000 feet it's 12.3 psi, and at 10,000 feet only 10.2 psi – a decrease of about 1/2 pound per 1,000 feet. This decreased pressure affects food preparation in two ways:

1. Water and other liquids evaporate faster and boil at lower temperatures.
2. Leavening gases in breads and cakes expand more quickly.

Cooking

The temperature at which water boils declines as elevation rises (Table 1). Because of this, foods prepared by boiling or simmering cook at a lower temperature at high altitude than at sea level, and thus, require a longer cooking time. Meats cooked by simmering or braising may require one-fourth more time at 5,000 feet than at sea level. Oven temperatures, however, are not affected by altitude, so sea-level instructions work for oven-roasted meats. Hard-cooked eggs will also take longer to cook. A “3-minute” egg may take 5 minutes to cook at 5,000 feet. High altitude areas are also prone to low humidity, which causes the moisture in foods to evaporate more quickly during cooking. Covering foods during cooking will help hold in moisture.

Table 1: Approximate boiling temperatures of water at various altitudes.

Altitude	Temperature
Sea level	212 °F
2,000 ft.	208 °F
5,000 ft.	203 °F
7,500 ft.	198 °F
10,000 ft.	193 °F

Deep-fat Frying

The lower boiling point of water in foods requires lowering the temperature of the fat to prevent food from over browning on the outside while being under-cooked on the inside. The decrease varies according to the food fried, but a rough guide is to lower the frying temperature about 3 degrees for every increase of 1,000 feet in elevation.

Microwave Cooking

Due to faster evaporation of liquids at high altitude, microwave cooking times may need to be adjusted. Follow your recipe or package instructions and use a food thermometer to determine if the safe minimum internal temperature has been reached, cooking longer if necessary.

Slow Cookers

At high altitudes, the slow cooker simmers at a lower temperature, making it more difficult for the food to reach a safe temperature and for bacteria to be destroyed. If your slow cooker has an adjustable temperature control, select a setting that will maintain the food at 200 °F or higher. If your slow cooker has both a HIGH and LOW setting, start the food cooking on HIGH for the first hour; then either continue to use HIGH or turn it to the LOW setting for the remainder of cooking. Allow longer cooking times at high altitudes and do not remove the lid. It can take 20 minutes or longer for the lost steam and heat to be regained each time the lid is lifted.

Canning

Fruits, tomatoes and pickled vegetables can be safely canned in a boiling water bath. However, because the temperature of boiling water is lower at higher elevations, you need to increase the processing time by 1 minute for each 1,000 feet above sea level if the sea level time is 20 minutes or less. If the processing time is more than 20 minutes, increase by 2 minutes per 1,000 feet.

Other vegetables, meats and poultry (low-acid foods) must be canned in a steam pressure canner at 240 °F for the appropriate time to destroy heat-resistant bacteria. At sea level to 2000 feet, 11 pounds of steam pressure will produce this temperature. Above 2,000 feet, steam pressure must be increased to reach 240 °F as illustrated in Table 2.

Table 2: Pressure required to reach 212 °F.

Altitude	Pressure Required
Sea Level-2,000 ft.	11 lb.
2,001-4,000 ft.	12 lb.
4,001-6,000 ft.	13 lb.
6,001-8,000 ft.	14 lb.
8,001-10,000 ft.	15 lb.

Freezing

An important step in preparing vegetables for freezing is heating or “blanching” before packing. At 5,000 feet elevation or higher, heat 1 minute longer than the blanching time given for sea level.

Candy, Syrup and Jelly Making

Both humidity and altitude affect candy making. To prevent excessive water evaporation during the cooking of sugar mixtures at altitude, cook to a “finish” temperature that is lower than that given in sea-level recipes. If you use a candy thermometer, first test the temperature at which your water boils, then reduce the finish temperature by the difference between the temperature of your boiling water and 212 °F. This is an approximate decrease of 2 degrees for every increase of

1,000 feet in elevation. You may also use the cold-water test, which is reliable at any altitude. Cook jellies to a finish temperature that is 8 degrees above the boiling point of your water.

Puddings and Cream-Pie Fillings

Above 5,000 feet, temperatures obtained with a double boiler are not high enough for maximum gelatinization of starch. Therefore, use direct heat rather than a double boiler.

Yeast Breads

High altitude has its most pronounced effect on the rising time of bread. The shortened rising period can interfere with flavor development, thus less yeast may be used to slow the rise time. Also, the dough can be proofed twice to allow more time for the gluten to fully develop. Dough should rise only until just double in bulk, as over-proofing can result in a heavy, collapsed loaf. Flours tend to be drier and thus able to absorb more liquid in high, dry climates. Therefore, less flour or possibly additional liquid may be needed to moisten the dough to proper consistency.

Bread Machines

Many bread machine manuals offer tips and special setting options for high altitude. Similar to suggestions for yeast breads above, the goal is to prevent over-rising and ensure proper consistency of the dough. Decrease yeast by ¼ to ½ teaspoon for every package (2 ½ tsp.) called for in the recipe. Add 1 to 2 tablespoons of additional liquid per cup of flour in the recipe. However, be careful not to add too much liquid. The dough must come clean from the sides during the final stages of mixing. Perhaps use a longer mixing cycle to allow the gluten to develop more fully.

Cakes

Above 3,000 feet elevation, decreased atmospheric pressure may result in excessive rising of cakes. The cell structure stretches, making the texture coarse, or breaks the cells, causing the cake to fall. This usually is corrected by decreasing the amount of leavening agent.

