High Altitude Food Preparation

Newcomers to Colorado or those traveling to the mountains are often surprised when favorite recipes made perfectly at sea level fail to produce expected results when made at higher elevation. Whether boiling eggs, preparing a roast or baking cookies, small adjustments can often improve the results. 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, available in the Resource section.

At altitudes above 3,000 feet, preparation of food may require changes in time, temperature or recipe. The reason— 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.

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.

Table 1: Approximate boiling temperatures of water at various altitudes

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

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. This includes vegetables, legumes, pot roasts, soups and stews.

- 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 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.

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 being fried, but as an estimate:

- **Lower the frying temperature about 3 degrees F 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.

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 degrees. **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.

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.

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, follow these guidelines for boiling water bath canning at elevation:

- **Increase processing time by 1 minute for each 1,000 feet above sea level if the sea level processing time is 20 minutes or less.**
- **If the sea level 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 degrees 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 degrees F as illustrated in Table 2.

Table 2: Pressure required to reach 240 degrees 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.

Yeast Breads

High altitude has its most pronounced effect on the rising time of bread. The shortened rise period can interfere with flavor development, thus less yeast may be used or the dough may be punched down, allowed to rise a second time, and punched down again before molding into loaves or rolls. Watch carefully to prevent over-rising. Allow dough to rise until just double in bulk, as over-proofing can result in a heavy, dry loaf or misshapen or 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 the proper consistency.

Bread Machines

Many bread machine manuals offer tips and special setting options for high altitude. General suggestions using bread machines at altitude may include:

- Decrease yeast by ¼ to ½ tsp. for every package (2 ½ tsp.) called for in the recipe.
- Add 1 to 2 T. 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.

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. When 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.

Cookies

Many cookie recipes contain a higher proportion of sugar and fat than necessary, even at low altitudes, causing cookies to sprawl on the baking sheet. Although many sea-level cookie 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 and/or sugar, and/or
- a slight increase in liquid ingredients and flour.

Pie Crusts

Although not generally affected by altitude, slightly more liquid may improve texture.

Practical Baking Notes

- Do not assume that your sea level recipe will fail. Try it first. It may need little or no modification. Often, repeated experiments with each recipe can give the most successful proportions to use. As a starting point, refer to Table 3. Try the smaller adjustment first, this may be all that is needed.
- For improved nutrition and a heartier texture, use whole wheat pastry flour in place of half the all-purpose flour called for in cookies, cakes and pies.
- Extra-large or an additional egg added to a recipe can provide added moisture and structure to baked goods and desserts at high altitudes.

Cakes Made with Shortening

Most cake recipes perfected for sea level need no modifications up to 3,000 feet. Above that, decreased atmospheric pressure may result in excessive rising, which stretches the cell structure of the cake, making the texture coarse, or breaks the cells, causing the cake to fall. Table 3 illustrates adjustments to make:

- Leavening: Measure accurately and reduce alike both baking powder and/or baking soda.
- Increase baking temperature by 15 to 25 degrees F to help "set" the batter before cells formed by the leavening gas expand too much.
- Excessive evaporation of water at high altitude leads to high concentration of sugar, which weakens the cell structure. Therefore decrease sugar in the recipe and increase liquid.
- In making rich cakes at high altitudes, you might have to reduce shortening by 1 or 2 tablespoons. Fat, like sugar, weakens the cell structure. Also, increasing the amount of egg strengthens the cell structure and may prevent the too-rich cake from falling.

Angel Food and Sponge Cakes

The leavening gas for these is largely air. Beat egg whites only until they form 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 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.

Resources

CSU Extension Fact Sheets

Visit the CSU Extension Farm to Table website for printable high altitude food preparation and preservation fact sheets:

Cost of Preserving and Storing Food
Food Preservation Without Sugar or Salt
Making Jellies
Canning Fruit
Canning Vegetables
Canning Tomatoes and Tomato Products
Making Pickles
Making Pickled Peppers
Processing Chili Peppers
Botulism
Freezing Fruit
Freezing Vegetables
Drying Fruits
Drying Vegetables
Leathers and Jerkies
Smoking Poultry Meat
Gluten-Free Baking

http://farmtotable.colostate.edu

CSU Extension County Offices

Family & Consumer Sciences Extension agents can assist you with:

- Food safety information and classes
- Food preservation workshops
- Master Food Safety Advisor volunteers
- Pressure canner gauge testing
- Cottage food business product support and more!

The following resources are also available for purchase from the CSU Extension Resource Center: www.csuextstore.com/store/pc/home.asp

- ***High Altitude Baking booklet;*** revised 2010. This 32 pg. booklet is a condensed version of the complete guide with recipes tested for altitudes between 3,000-7,000 feet. ($5.00)

- ***A Complete Guide to High Altitude Baking;*** 2005. Editor P. Kendall, Colorado State University Extension. A collection of 200 delicious recipes and tips for perfect high altitude cookies, cakes, breads and more. ($14.95)

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https://ask.extension.org/ask

References

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

Developed by Patricia Kendall, CSU Food Science & Human Nutrition professor and Extension specialist ; revised 2013 by CSU Extension.