High Altitude Food Preparation

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. 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 "three-minute" egg may take five 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 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

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 one 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 two 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.

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 degrees. This is an approximate decrease of two degrees F 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 eight degrees F above the boiling point of your water.

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 F for every increase of 1,000 feet in elevation.

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.

Breads

High altitude has its most pronounced effect on the rising time of bread. At high altitudes, the rising period is shortened. Since the development of a good flavor in bread partially depends on the length of the rising period, it is well to maintain that period. Punching the dough down twice gives time for the flavor to develop.

In addition, flours tend to be drier and thus able to absorb more liquid in high, dry climates. Therefore, less flour may be needed to make the dough the proper consistency.

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. This usually is corrected by decreasing the amount of leavening agent. Increasing the baking temperature 15 to 25 degrees F can also help "set" the batter before

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High Altitude

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Colorado State University has a long tradition of high-altitude baking research. Over the years, researchers with the Department of Food Science and Human Nutrition have developed altitude-tested recipes for use in high altitude areas, supported by Colorado State University's Extension and Agricultural Experiment Station. As a result, Colorado State University Extension is able to offer the publications listed on the back of this panel to consumers.

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the 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. Only repeated experiments with each recipe can give the most successful proportions to use. Table 3 is a helpful starting point. Try the smaller adjustment first, this may be all that is needed.

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.

Table 3: Cake-recipe adjustment guide for high altitude.

Adjustment	*3000 ft.*	*5000 ft.*	*7000 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.

Angel Food and Sponge Cakes

The leavening gas for these is largely air. Do not beat too much air into the eggs. Beat egg whites only until they form peaks that fall over - 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.

Cookies

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 or sugar, and/or a slight increase in liquid ingredients. Many cookie recipes contain a higher proportion of sugar and fat than necessary, even at low altitudes.

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.

Pie Crusts

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

Practical Baking Notes

Use any brand of enriched all-purpose or cake flour.

Do not assume that your sea level recipe will fail. Try it first. It may need little or no modification.

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Revised 01/2009

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