High Altitude Cooking

Cooperative Extension Service
College of Agriculture and Home Economics

Guide E-215

Martha Archuleta, Extension Food and Nutrition Specialist

This publication is scheduled to be updated and reissued 7/05.

High altitude presents several challenges when preparing some foods. First, leavened products, using either yeast, baking powder, baking soda, egg whites or steam, rise more rapidly and often collapse. Second, foods such as vegetables and stews cooked with moist heat take much longer to prepare.

Atmospheric (air) pressure is 14.7 pounds per square inch (psi) at sea level; at 5,000 ft altitude, it is 12.28 psi; and at 10,000 ft, 10.2 psi. The relationship is inverse: the higher the elevation, the lower the air pressure. At higher altitudes then, air pressure is less on both leavened products and the surface of boiling liquids.

As atmospheric pressure decreases, water boils at lower temperatures. At sea level, it boils at 212°F while each 500-ft increase in altitude causes a drop of about 1° in the boiling point. At very high altitudes, boiling water is relatively "cool." Since heat, not boiling, cooks foods at higher altitudes, more time is required for food to reach the desired internal cooking temperature.

Low humidity, not necessarily an altitude factor but certainly a reality in New Mexico, causes ingredients such as flour to dry out and may produce dry, crumbly baked products.

The following guidelines will reduce the number of baking failures or partially cooked foods frequently experienced by those living at high altitudes with low humidity.

FOODS COOKED WITH MOISTURE

Vegetables, legumes, pot roasts, soups, and stews prepared at a 5000 ft altitude require additional cooking time. Vegetable cookery is greatly affected by size, variety, and maturity of the product, and adjustments must be made accordingly at any altitude. Preparation time can be reduced by one-fourth to one-third by using a pressure saucepan, which causes the temperature of boiling water to increase as pressure builds within the sealed container.

Meat cooked by simmering or braising requires additional time at higher altitudes. In general, one-fourth more time may be required at 5,000 ft. than at sea level. Use the sea-level time and temperature when oven-roasting meats, as oven temperatures are not affected by altitude changes.

Hard-cooked eggs require additional time. Place cold eggs in a saucepan, and cover with cool tap water. Cover and set heat on high. When water temperature approaches a gentle simmer, reduce heat to a low setting. At 5000 ft it will take about 25 minutes for eggs to cook. The traditional 3-minute egg may take 5 to 6 minutes.

CANDIES AND FROSTINGS

Boiling causes loss of moisture through evaporation; thus, the lower the boiling point, the sooner evaporation begins. At high altitudes all liquids boil at temperatures below 212°, requiring adjustments for candies and frostings.

When sugar mixtures are cooked to the temperatures suggested in sea-level recipes, at high altitudes the faster water loss causes the mixture to become too concentrated. Depending on the candy or sugar mixture, the results may become "sugary" or hard as the sugar re-crystallizes.

To adjust sugar recipes for altitude, reduce the "finish" temperature. If you use a candy thermometer, first test the temperature at which water boils. While weather conditions may cause minor changes from day to day, the range is usually slight. The finish temperature should be reduced by the difference between the water boiling temperature and 212° (table 1).

Table 1. Sugar cookery adjustment.

Product	Cold-water test	Finish temperature			
		Sea level	2,000 ft	5.000 ft	7,500 ft
Creamy candies and fillling	Soft ball	234-240°F	230-236°F	224-230°F	219-225°F
Chewy candies	Firm ball	242-248° F	238-244°F	232-238°F	227-233°F
Pulled candies, fillings, and frostings with egg whites	Hard ball	250-268°F	246-264°F	240-248°F	235-253°F
Toffees	Soft crack	270-290°F	266-286°F	260-280°F	255-275°F
Brittles	Hard crack	300-310°F	296-306°F	290-300°F	285-295°F

At 5,000-foot altitude, water boils at approximately 202°, 10° less than at sea level; thus reduce the finish temperature for the candy or frosting by 10°. For example, if a sea-level recipe for creamy fudge gives a finish temperature of 238°, the corrected thermometer reading would be 228° at 5000 ft. The cold-water test is reliable at any altitude as it depends solely upon the appearance of the candy in water.

Rocky Mountain Frosting

1 cup sugar
1/4 cup water
1/4 cup white corn syrup
1 egg white
2 marshmallows
1/2 teaspoon vanilla
1/4 teaspoon almond extract

Cook sugar, water and corn syrup until mixture forms a firm soft ball in cold water (231° at 5,000 ft). Beat egg white until it forms a soft peak that droops slightly; cut marshmallows in eighths and add to candy mixture.

Gradually pour hot syrup on egg white mixture, beating continuously until icing holds shape and is practically cold. Add flavorings and spread on cool cake. Makes frosting for top and sides of two 9-inch layers.

JELLY

The finish temperature for jelly is 220° at sea level, or 8° above the boiling point of water. At 5,000 ft jelly should be cooked to 210° as water usually boils at 202° at that altitude.

The "sheet" test from a metal spoon remains reliable at all altitudes. As jelly thickens in cooking, individual drops run together into a "sheet" that breaks cleanly off the edge of the spoon.

DEEP-FAT DRYING

Deep-fat frying vaporizes the moisture in foods, and liquids vaporize at lower temperatures in higher altitudes. To prevent fried foods from being dry when cooked at high altitudes, decrease the temperature 2-3° for each 1,000 ft of elevation. For example, fry doughnuts at 350-360° at 5,000 ft, rather than the temperature of 370° specified in the recipe.

LEAVENED CAKES AND BREADS

At altitudes above 3,500 ft, increase the oven temperature 25° over the temperature required at sea level unless using glass pans when no increase is needed. (Glass does not conduct heat as efficiently as metal.) For example, cakes baked in metal pans at sea level at 350° should be baked at 375° at all altitudes over 3,500 ft. Faster baking "sets" the cell framework within the flour mixture and helps prevent falling. Use this adjustment for all leavened foods that are high in sugar and shortening.

In areas of low humidity, dry ingredients (specifically flour) become excessively dry unless stored in air-tight containers. A scant decrease in flour or an additional tablespoon of liquid per cup of flour will often bring a batter or dough to the correct consistency.

Recipes must be adjusted for flour mixtures that contain considerable amounts of sugar and shortening

and that are leavened with carbon dioxide gas from baking powder or soda and acid (table 2).

Some sea-level cakes are delicate and defy adjustment to varying altitudes. Rather than try to adjust such recipes, choose a new favorite from altitude-tested recipes, such as the pound cake recipe below. Other recipes, especially commercial cake mixes, are so well balanced that little, if any, adjustment may be necessary up to 5,000 ft. *"Cake and Mix Recipes for High Altitudes in New Mexico"* is available for a small fee from the NMSU'S Cooperative Extension Service.

Cakes without fat: Air from beaten eggs is the leavening agent. For angel food cakes beat egg whites until they form peaks that droop slightly; in sponge cakes, beat eggs or egg yolks until slightly thickened.

Cakes with fat: Solid shortening gives good results in high altitude baking because the emulsifier enables the shortening to tolerate a larger amount of liquid. Solid shortening is preferred for "speed-mix" cakes with a high sugar ratio.

Flour: All-purpose flour is preferred as its high gluten content provides strength. Always sift before measuring and make the following adjustments per cup of flour (table 2).

Egg: An additional egg provides moisture and strength.

Leavening: Baking powders and baking soda are treated alike in reductions for increased altitudes. When both baking powder and soda are used in a recipe, make the suggested adjustments in both ingredients. Accurate measurement of leavening is critical as altitude increases.

Table 2. Flour adjustments.

Elevation in feet	Increase flour
3,500 to 5,000	1 tablespoon
5,000 to 6.500	2 tablespoons
6,500 to 8,000	3 tablespoons
8,000 and over	4 tablespoons

Where two amounts appear below, try the smaller adjustment first. If the cake still needs improvement, use the larger adjustment (table 3).

Table 3. Leavening, sugar, and liquid adjustments

Adjustment	3,000 ft	5,000 ft	7,000 ft
Baking powder			
for each teaspoon, decrease	1/8 tsp	1/8 to 1/4 tsp	1/4 tsp
Sugar			
for each cup, decrease	0 - 1 Tbsp	0 - 2 Tbsp	1 - 3 Tbsp
Liquid			
For each cup, add	1 t-2 Tbsp	2 - 4 Tbsp	3 - 4 Tbsp

Because of the varying proportions of ingredients in recipes, definite rules cannot be strictly applied for all recipe adjustments Each recipe needs to be tested individually. Always pencil in changes made to "scratch" recipes.

Quick-Mix Pound Cake

The high sugar ratio in this cake is balanced by the emulsifier in the shortening that allows for a large amount of liquid. This excellent recipe does not conform to the general rule for adjustment of cake recipes.

3 cups cake flour
1 3/4 cups sugar
1 teaspoon double-acting baking powder
1 1/2 teaspoons salt
3/4 cup shortening
4 eggs plus enough milk to make one cup
3/4 cup milk
1 1/2 teaspoons flavoring

Baking time: 1 1/4 hours
Oven temperature: 350°F

Place sifted dry ingredients in large mixing bowl and cut in shortening. Break eggs into a one-cup measuring cup and add enough milk to make one cup. Stir eggs and milk and pour into dry ingredients. Beat on medium speed 3 minutes or 300 strokes by hand. Clean sides of bowl with scraper.

Add an additional 3/4 cup milk and flavoring and beat for 2 minutes or 200 strokes. Pour into 10-inch tube pan in which the bottom has been greased and floured. Remove from oven and cool upright completely before removing cake from pan.

YEAST BREADS

Good basic recipes for yeast breads are reliable at most altitudes, but as fermentation of sugar in bread is

faster at higher altitudes, bread may rise in one-third to one-fourth of the time required at lower altitudes. Watch carefully and punch down when dough doubles in bulk. As one package of yeast can raise 12 cups of flour, some cooks will reduce the yeast by half and punch down the dough when it doubles in bulk.

To prevent dry yeast breads, add about three-fourths of the flour specified in the recipe or enough to make a stiff batter. Allow batter to absorb moisture for about ten minutes. Add only enough flour to make a soft dough that is handled easily.

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, fat, and sugar; and/or a slight increase in liquid ingredients and flour.

Many cookie recipes contain a higher proportion of sugar and fat than necessary, even at low altitudes. For more nutritious cookies with fewer calories, up to one-fourth of the sugar can be replaced with nonfat dry milk powder without loss in product quality.

QUICK LEAVENED BREADS

Biscuits: Any standard recipe can be relied on to give good results at varying altitudes. However, adding a tablespoon of milk to each cup of flour and reducing baking powder slightly will improve the quality of the product at high altitudes.

Muffins: If muffins seem dry, reduce sugar by at least one teaspoon. Otherwise, standard muffin recipes work well at most altitudes.

Fruit, Nut, Vegetable Quick Breads: If these breads seem dry, reduce sugar. Usually both shortening and sugar can be reduced by as much as one-fourth of the total amount specified and still provide a tasty bread.

Popovers: Popover batter is strengthened if the egg in the batter is increased and the shortening reduced. This creates a stronger batter to retain the steam long enough for a crust to form. Creampuffs do not require any correction for altitude.

POPOVERS

1 cup sifted all-purpose flour
1 teaspoon sugar
1/4 teaspoon salt
1 cup milk
2 large eggs
1 Tablespoon margarine or butter, melted

Oven temperature: 450°
Yield: 11 medium popovers
Pan: Grease popover cup or muffin tin cups

Sift flour, salt, and sugar together. Combine milk, eggs, and butter or margarine and add it to the dry ingredients. Beat the mixture until smooth and well blended (1—4 minutes).

Pour batter into greased popover or deep muffin pans, fill each cup half full and bake for 15 minutes. Reduce heat to 325° and continue baking for 25 minutes. Popovers are done when side walls are firm.

SUMMARY

Good, high-quality foods can be prepared at any altitude. To assure success at high altitudes, remember these four principles:

- Decrease leavening in cakes.
- Either decrease yeast or allow bread to rise a shorter time when making yeast-leavened breads.
- Foods cooked in liquids, with or without a pressure saucepan, must by cooked longer.
- Cook candy, frosting, and jelly to lower finish temperatures.

Extension publications on high-altitude, home canning are available by calling (505)646-2701, or online at http://www.cahe.nmsu.edu/pubs.

Original publication written by Alice Jane Hendley,
Extension Specialist Emerita

Reprinted July 2000 **Las Cruces, NM**
5C