



# High Altitude Cooking and Food Safety

*Fully one-third of the population of the United States lives at high altitudes. Cooking at a high altitude requires some special considerations. The thin air — less oxygen and atmospheric pressure — affects both the time and the temperature of most everything that's cooked. Where the altitude is above 3,000 feet, special cooking methods are needed for meat and poultry.*

## What is Considered a High Altitude?

Most cookbooks consider 3,000 feet above sea level to be high altitude, although at 2,000 feet above sea level the boiling temperature of water is 208 °F instead of 212 °F. Most of the western United States (Alaska, Arizona, California, Colorado, Idaho, Montana, Nebraska, New Mexico, Nevada, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming) are wholly or partly at high altitude, however many other states contain mountainous areas that are also well above sea level.

## How is the Air Different at High Altitudes?

Above 2,500 feet, the atmosphere becomes much drier. The air has less oxygen and atmospheric pressure, so cooking takes longer. Moisture quickly evaporates from everything. For this reason uncovered food will dry out quickly while cooking.

## How Do High Altitudes Affect Cooking?

At altitudes above 3,000 feet, preparation of food may require changes in time, temperature or recipe. The reason is the lower atmosphere pressure due to a thinner blanket of air above. At sea level, the air presses on a square inch of surface with 14.7 pounds pressure; at 5,000 feet with 12.3 pounds pressure; and at 10,000 feet with only 10.2 pounds pressure -- 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.

As atmospheric pressure decreases, water boils at lower temperatures. At sea level, water boils at 212 °F. With each 500-foot increase in elevation, the boiling point of water is lowered by just under 1 °F. At 7,500 feet, for example, water boils at about 198 °F. Because water boils at a lower temperature at higher elevations, foods that are prepared by boiling or simmering will cook at a lower temperature, and it will take longer to cook.

High altitude areas are also prone to low humidity, which can cause the moisture in foods to evaporate more quickly during cooking. Covering foods during cooking will help hold in moisture.

## Why Must Cooking Time Be Increased?

As altitude increases and atmospheric pressure decreases, the boiling point of water decreases. To compensate for the lower boiling point of water, the cooking time must be increased. Turning up the heat will not help cook food faster. No matter how high the cooking temperature, water cannot exceed its own boiling point – unless if using a pressure cooker. Even if the heat is turned up, the water will simply boil away faster and whatever is being cooked will dry out quicker.

### How Do High Altitudes Affect the Cooking of Meat and Poultry?

Meat and poultry products are composed of muscle, connective tissue, fat, and bone. The muscle is approximately 75% water (although different cuts of meat may have more or less water) and 20% protein, with the remaining 5% representing a combination of fat, carbohydrates and minerals. The leaner the meat, the higher the water content (less fat means more protein, thus more water).

With such high water content, meat and poultry are susceptible to drying out while being cooked if special precautions are not taken. Cooking meat and poultry at high altitudes may require adjustments in both time and moisture. This is especially true for meat cooked by simmering or braising methods. Depending on the density and size of the pieces, meats and poultry cooked by moist heat methods may take up to **one-fourth more cooking time** when cooked at 5,000 feet. Use the sea-level time and temperature guidelines when oven-roasting meat and poultry, as oven temperatures are not affected by altitude changes.

Moist heating methods, such as braising (food is first browned in fat, then cooked, tightly covered, in a small amount of liquid at low heat for a lengthy period of time) often yield more juicy and tender meat than meat cooked by oven roasting or broiling. Moist cooking methods also help the meat retain moisture. Since moist heat helps to break down connective tissue, it can tenderize tougher cuts of meat. Whenever possible, prevent burning by adding additional liquids. Sour cream, meat broth, and sauces can be added. Meat tenderizers are also helpful.

When braising or stewing meats, use heavy cookware with tight fitting lids. This will prevent scorching and water evaporation. Another way to hold in meat juices and steam is to cover the pot or pan with aluminum foil before putting the lid on. Commercial cooking bags will also hold in moisture. If dry-roasting meat and poultry, frequent basting may help hold in juices; however, basting may add additional time to the total cooking time as heat is lost each time the oven door is opened.

### Why is a Food Thermometer Helpful?

A food thermometer is the only way to measure whether food has reached a safe internal temperature. In a high altitude environment, it is easy to overcook meat and poultry or scorch casseroles. To prevent overcooking meat and poultry (which will result in dry, unappetizing food) or to prevent undercooking (which can result in food poisoning), check food with a food thermometer.

### Where to Place the Food Thermometer

**Meat:** When taking the temperature of beef, pork, or lamb roasts, the food thermometer should be placed in the thickest part of the roast, avoiding the bone. When cooking hamburgers, steaks, or chops, insert a digital food thermometer in the thickest part, away from bone, fat, or gristle. When the food being cooked is irregularly shaped, such as with a beef roast, check the temperature in several places.

**Poultry:** A whole turkey, chicken, or other poultry is safe cooked to a safe minimum internal temperature of 165 °F as measured with a food thermometer. Check the internal temperature in the innermost part of the thigh and wing and the thickest part of the breast. For reasons of personal preference, consumers may choose to cook poultry to higher temperatures.

For optimum safety, do not stuff whole poultry. If stuffing whole poultry, the center of the stuffing must reach a safe minimum internal temperature of 165 °F.

If cooking poultry parts, insert the food thermometer into the thickest area, avoiding the bone. The food thermometer may be inserted sideways if necessary. When the food is irregularly shaped, the temperature should be checked in several places.

**Thin Foods:** When measuring the temperature of a thin food, such as a hamburger patty, pork chop, or chicken breast, a digital food thermometer should be used, if possible.

However, if using an “instant-read” food thermometer, the probe must be inserted in the side of the food so that the entire sensing area (usually 2-3 inches) is positioned through the center of the food.

To avoid burning fingers, it may be helpful to remove the food from the heat source (if cooking on a grill or in a frying pan) and insert the food thermometer sideways after placing the item on a clean spatula or plate.

**Combination Dishes:** For casseroles and other combination dishes, place the food thermometer into the thickest portion of the food or the center of the food. Egg dishes and dishes containing ground meat and poultry should be checked in several places.

## Recommended Internal Temperatures

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<b>MEAT</b>	
Fresh ground meats Beef, veal, lamb, and pork	160 °F
Beef, veal, lamb (roasts, steaks, chops)	
· Medium rare	145 °F
· Medium	160 °F
· Well done	170 °F
Fresh Pork (roasts, steaks, chops)	160 °F
Ham, cook before eating:	160 °F
Ham, reheat fully cooked:	140 °F
<b>POULTRY</b>	
· Ground chicken, turkey	165 °F
· Whole chicken, turkey	165 °F
· Breasts, roasts	165 °F
· Drumsticks, thighs, wings	165 °F
<b>COMBINATION FOODS</b>	
· Stuffing, alone or in bird	165 °F
· Egg dishes, casseroles	160 °F
· Leftovers, to reheat	165 °F

## Is Egg Cookery Affected at High Altitudes?

Yes, it can take longer to cook eggs at high altitudes, especially those cooked in boiling water such as poached and hard-cooked eggs. Because water boils at a lower temperature at high altitudes, hard-cooked eggs will take longer to prepare. It will most likely take longer to hard cook eggs at high altitudes than at sea level.

Many cooking methods can be used to cook eggs safely at high altitudes including poaching, hard cooking, scrambling, frying and baking. In general, do not increase the heat, just increase the cooking time. Eggs must be cooked thoroughly until yolks are firm. Scrambled eggs should not be runny. Casseroles and other dishes containing eggs should be cooked to 160 °F. Use a food thermometer to be sure.

At high altitudes, extra-large eggs give added moisture and structure to baked goods and desserts. Smaller eggs will result in batter that is less stable and more likely to fall during baking. Also, increasing the amount of egg strengthens the cell structure and may prevent the too-rich cake from falling.

### Is Cooking Affected When Using Microwaves at High Altitudes?

Due to the faster evaporation of liquids at high altitude, microwave cooking may take **less time** than at sea level. There are exceptions: meat, poultry, pasta, and rice require the maximum cooking time. Follow the manufacturer's instructions or recipe and microwave for slightly less than the minimum length of time recommended. Add cooking time, if necessary. Use a food thermometer to determine if the safe minimum internal temperature has been reached.

### Is Cooking Affected When Using Small Electrical Appliances at High Altitudes?

When browning meat or poultry in a small electrical appliance such as an electric skillet or wok, the temperature of the appliance will at first decrease as the cold food contacts the hot surface. To keep the temperature constant, watch the heat and adjust it if needed.

To maintain or increase the cooking temperature of electric skillets and woks, keep the lid on and vents shut to hold heat and steam inside. Covering the skillet or wok with aluminum foil before placing the cover on also helps hold the heat inside and prevent loss of steam. Adding liquid periodically will increase the temperature and prevent the food from scorching and drying out.

When 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 a rough guide is to lower the frying temperature about 3 °F for every increase of 1,000 feet in elevation.

### How Do High Altitudes Affect Cooking with a Slow Cooker?

Always thaw food thoroughly before putting it in a slow cooker (at any altitude). Remember that when cooking at high altitudes, water boils at a lower temperature. Water is essential to slow cooking. The water and the steam conduct heat throughout the food in the slow cooker. 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.

Check the manufacturer's instructions. 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. The low setting may also be used for keeping food warm.

Allow longer cooking times at high altitudes. Do not remove the lid from the slow cooker; it can take 20 minutes or longer for the lost steam and heat to be regained. It may be helpful to place aluminum foil on top of the foods being cooked in a slow cooker and under the lid. The aluminum foil will reflect the heat downward into the food. Use a food thermometer to ensure that all food in the slow cooker has reached a safe minimum temperature (at least 160 °F; 165 °F if the recipe contains poultry.)

## Is Cooking Affected When Using a Pressure Cooker at High Altitudes?

At high altitudes, the pressure cooker is an essential kitchen tool. By cooking under pressure you are in effect increasing the atmospheric pressure and therefore, increasing the boiling temperature of water. Food will cook faster and more thoroughly.

Pressure cookers come with one or more pre-set weighted gauges. If your pressure cooker only comes with one weighted gauge, you will need to increase the cooking time to account for the lower cooking temperature at higher altitudes. If the pressure cooker has more than one weight, you may be able to make the needed adjustment by using the higher weight. Be sure to follow the directions that come with the pressure cooker for making altitude adjustments for the type of pressure cooker you are using. If there are no recommendations for altitude adjustment, contact the manufacturer directly.

To prevent water evaporation, once the desired pressure is reached on the pressure cooker, the heat can be reduced. Regulate the heat under the canner to maintain a steady pressure at, or slightly above, the correct gauge pressure. Check the manufacturer's directions for maintaining pressure.

## How Should Home Canning Processes Be Altered?

Even at sea level, meat and poultry (as well as low-acid vegetables and fish) must be processed using a steam pressure canner. If using a dial gauge at high altitudes, the pressure in the canner must be increased by 1 pound of pressure for each 2,000 feet above sea level. If using a weighted gauge, the 15 pound weight must be used at all altitudes above 1,000 feet. You do not need to add additional processing time if the pressure of the canner is adequately adjusted.

Pressure Required to Reach 240 °F	
ALTITUDE	PRESSURE REQUIRED
Sea Level	10 pounds
2,000 feet	11 pounds
3,000 feet	11.5 pounds
4,000 feet	12 pounds
5,000 feet	12.5 pounds
7,000 feet	13.5 pounds
10,000 feet	15 pounds

All home-canned foods should be canned according to USDA or USDA-endorsed recommendations. Low-acid and tomato foods not canned using these methods present a risk of botulism. If there is a possibility that any deviation from the USDA-endorsed methods occurred, boil low-acid and tomato foods in a saucepan before consuming to prevent the risk of botulism. At altitudes below 1,000 feet, boil foods for 10 minutes. Add an additional minute of boiling time for each additional 1,000 feet elevation (for example, at 3,000 feet, boil for 12 minutes).

Spinach and corn should be boiled for 20 minutes at all altitudes. This is due to the high density of these vegetables.

## Keep Hot Food Hot

- If serving hot food on a buffet table, an electric slow cooker will keep cooked food hot enough (140 °F or above) to be safe.
- Chafing dishes or candle warmers cannot produce enough heat to keep hot food hot.
- If a slow cooker is not available, keep hot food in a warm oven (225-250 °F) and put small dishes of hot food on the buffet table. Use a food thermometer to make sure that hot food maintains a 140 °F or higher temperature. Replace the dishes with hot food fresh from the oven frequently.
- Food poisoning bacteria grow rapidly in the “Danger Zone” — temperatures between 40 and 140 °F — and most rapidly between 90 and 110 °F.

## Keep Cold Food Cold

On the buffet table, keep cold food cold by nesting dishes in bowls of ice or use small serving trays, and replace them often. If perishable foods are left at room temperature for more than 2 hours, harmful bacteria can multiply and cause foodborne illness. When temperatures are 90 °F or higher, limit the time foods sit out of refrigeration to just 1 hour. Foods left at room temperature will also dry out faster at high altitudes. For safety's sake, keep perishable foods, such as meats, poultry, and eggs, in the refrigerator at 40 °F or below.

## Where to Get More Information about Cooking at High Altitude

Contact the Cooperative Extension service in your county. If you live in a high altitude area, the Extension service will have detailed information about cooking.

Colorado State University Cooperative Extension contributed to the content of this publication. For additional information about high altitude cooking, see the CSU Cooperative Extension “High Altitude Food Preparation Guide” at: <http://cerc.colostate.edu/titles/P41.html>.

## Food Safety Questions?

### Call the USDA Meat & Poultry Hotline

If you have a question about meat, poultry, or egg products, call the USDA Meat and Poultry Hotline toll free at **1-888-MPHotline (1-888-674-6854)**; TTY: 1-800-256-7072.



The Hotline is open year-round Monday through Friday from 10 a.m. to 4 p.m. ET (English or Spanish). Recorded food safety messages are available 24 hours a day. Check out the FSIS Web site at [www.fsis.usda.gov](http://www.fsis.usda.gov).

Send E-mail questions to [MPHotline.fsis@usda.gov](mailto:MPHotline.fsis@usda.gov).

### Ask Karen!

FSIS' automated response system can provide food safety information 24/7.



[AskKaren.gov](http://AskKaren.gov)