



## Microwave Ovens and Food Safety

*The microwave oven is one of the great inventions of the 20th century; over 90% of homes in America have at least one. Microwave ovens can play an important role at mealtime, but special care must be taken when cooking or reheating meat, poultry, fish, and eggs to make sure they are prepared safely. Microwave ovens can cook unevenly and leave "cold spots" where harmful bacteria can survive. For this reason, it is important to use a food thermometer and test food in several places to be sure it has reached the recommended safe temperature to destroy bacteria and other pathogens that could cause foodborne illness.*

### How do microwaves cook food?

The magnetron inside the oven converts ordinary electric power from a wall socket into very short radio waves (around 4 inches from crest to crest). They are transmitted by the oven's magnetron at a frequency of about 2450 Megahertz. At that frequency, power is readily absorbed by water, fats and sugars, resulting in very fast vibration and high temperatures that cook the food.

### What are power levels?

On high power, the food is subjected to the highest amount of microwave energy because the magnetron produces microwaves at full capacity. To produce a power level less than high (100%), the magnetron cycles off and on. For example, medium power (50%) means that the oven produces microwaves 50% of the time and is off 50% of the time.

Foods best to cook on high power are basically tender foods and those with a high moisture content such as ground beef, poultry, vegetables and fruits. Eggs, cheese and solid meat can toughen when microwaved on high. They are best cooked on reduced power. Large cuts of meat should be cooked on medium power (50%) for longer periods. This allows heat to reach the center without overcooking outer areas.

### Do microwaves cook food from the inside out?

No. Microwaves penetrate the food to a depth of 1 to 1 1/2 inches. In thicker pieces of food, the microwaves don't reach the center. That area would cook by conduction of heat from the outer areas of the food into the middle.

In a microwave oven, the air in the oven is at room temperature so the temperature of the food surface is cooler than food in a conventional oven where the food is heated by hot air. Therefore, food cooked in a microwave oven doesn't normally become brown and crispy.

### Do microwaves cook food safely?

Bacteria will be destroyed during microwave cooking just as in other types of ovens, so food is safe cooked in a microwave oven. However the food can cook less evenly than in a conventional oven. Microwave cooking can be uneven just as with frying and grilling.

For that reason, it is important to use a food thermometer and test food in several places to be sure it has reached the recommended temperature to destroy bacteria and other pathogens that could cause foodborne illness.

To promote uniform cooking, arrange food items evenly in a covered dish and add some liquid if needed. Where possible, debone large pieces of meat; bone can shield meat from thorough cooking.

Cover the dish with a lid or plastic wrap. Allow enough space between the food and the top of the dish so that plastic wrap does not touch the food. Loosen or vent the lid or wrap to allow steam to vent. The moist heat that is created will help destroy harmful bacteria and ensure uniform cooking. Cooking bags also provide safe, even cooking.

Stir, rotate, or turn food upside down (where possible) midway through the microwaving time to even the cooking and eliminate cold spots where harmful bacteria can survive. Even if the microwave oven has a turntable, it's still helpful to stir and turn food top to bottom.

Follow cooking instructions on product label (or recipe instructions). If a range of time is given, start with the fewest minutes recommended. Add cooking time if necessary to reach a safe internal temperature.

Observe the "standing time." Cooking continues and is completed during standing time. Most importantly, follow the manufacturer's instructions.

### What is "standing time"?

Microwaves cause water, fat, and sugar molecules to vibrate 2.5 million times per second, producing heat. After the oven is off or food is removed from the oven, the molecules continue to generate heat as they come to a standstill. This additional cooking after microwaving stops is called "carryover cooking time," "resting time," or "standing time." It occurs for a longer time in dense foods such as a whole turkey or beef roast than in less-dense foods like breads, small vegetables and fruits. During this time, the temperature of a food can increase several degrees. For that reason, directions may advise to let a food "rest" for a few minutes after turning off the oven or removing food from the oven.

Use a food thermometer or the oven's temperature probe to verify the food has reached a safe internal temperature. Unless the food thermometer is labeled safe for microwave cooking, do not leave the thermometer in the food during microwaving. Instead, use an instant read food thermometer to test the temperature of the food after removing it from the microwave oven.

### What are the USDA recommended temperatures for microwaving food safely?

Place the thermometer in the thickest area of the meat or poultry — not near fat or bone — and check the temperature in the innermost part of the thigh and wing and in the thickest part of the breast of whole poultry. Cooking times may vary because ovens vary in power and efficiency.

- Cook ground meats to 160 °F; ground poultry to 165 °F.
- Beef, veal, and lamb steaks, roasts, and chops may be cooked to 145 °F; all cuts of fresh pork, 160 °F.
- Poultry should reach a safe minimum internal temperature of 165 °F.
- Eggs and casseroles containing eggs, 160 °F.
- Fish should reach 145 °F.
- Always allow standing time, which completes the cooking, before checking the internal temperature with a food thermometer.

### **Is it safe to microwave food only until partially done?**

Never partially cook food and store it for later use because any bacteria present wouldn't have been destroyed. When partially cooking food in the microwave oven to finish cooking on the grill or in a conventional oven, it is important to transfer the microwaved food to the other heat source immediately.

### **Is it safe to cook stuffed poultry in a microwave oven?**

Cooking whole, stuffed poultry in a microwave oven is not recommended. Because food cooks so quickly in a microwave oven, the stuffing might not have enough time to reach the temperature needed to destroy harmful bacteria.

### **What is the best way to thaw frozen food in a microwave oven?**

Remove food from its packaging before defrosting. Do not use foam trays and plastic wraps because they are not heat stable at high temperatures. Melting or warping from the heat of the food may cause harmful chemicals to migrate into it.

Select the "defrost" setting or 30% power. During microwave defrosting, rotate and turn food upside down where possible. For individual pieces such as chicken parts, break them apart when possible, rotate and turn upside down several times during defrosting. When thawing ground meats, scrape the thawed portion off as it softens; remove it from the oven. Continue to microwave defrost the remaining portion.

Cook meat, poultry, egg casseroles, and fish immediately after defrosting in the microwave oven because some areas of the frozen food may begin to cook during the defrosting time. Do not hold partially cooked food to use later.

### **How do you safely reheat cooked food in a microwave oven?**

Cover foods with a lid or a microwave-safe plastic wrap to hold in moisture and provide safe, even heating. Turn back a corner for the steam to vent.

Heat ready-to-eat foods such as hot dogs, luncheon meats, fully cooked ham, and leftovers until steaming hot.

After reheating foods in the microwave oven, allow standing time. Then, use a clean food thermometer to check that food has reached 165 °F.

### **What containers and wraps are safe to use in the microwave oven?**

Only use cookware that is specially manufactured for use in the microwave oven. Glass, ceramic containers, and all plastics that are safe to use usually will be labeled for microwave oven use.

#### **SAFE TO USE:**

- Any utensil labeled for microwave use.
- Heatproof glass (such as Pyrex, Anchor Hocking, etc.).
- Glass-ceramic (such as Corning Ware).
- Oven cooking bags.
- Baskets (straw and wood) for quick warm-ups of rolls or bread. Line the basket with napkins to absorb moisture from food.
- Most paper plates, towels, napkins and bags. For optimal safety use white, unprinted materials.
- Wax paper, parchment paper, heavy plastic wrap. Do not allow plastic wrap to touch food; vent it to allow a steam escape.
- Heat-susceptor packaging.

### **NOT SAFE TO USE:**

- Cold storage containers: margarine tubs, cottage cheese and yogurt cartons, etc. These materials are not approved for cooking and chemicals can migrate into food.
- Brown paper bags and newspapers.
- Metal pans.
- Foam-insulated cups, bowls, plates or trays.
- China with metallic paint or trim.
- Chinese "take-out" containers with metal handles.
- Metal "twist ties" on package wrapping.
- Food completely wrapped in aluminum foil.
- Food cooked in any container or packaging that has warped or melted during heating.

### **Is it safe to use aluminum foil in a microwave oven?**

Always consult the owner's manual of your microwave oven and heed the manufacturer's recommendations for the use of aluminum foil. It can be safe to use small amounts of aluminum foil in a microwave oven.

Microwaves cannot pass through metal but are absorbed by food. No food completely covered by aluminum foil or in a covered metal pan should be put into a microwave oven because food wouldn't be available to absorb the microwaves. Operating the oven empty or when the food is completely wrapped in aluminum foil can cause damage to the oven and the food won't heat.

However, small pieces of aluminum foil can be used to "shield" areas of foods, such as poultry drumsticks and wings, to prevent overcooking.

Some food packaged in foil containers can be safe to microwave. Read the package heating instructions to see if the food manufacturer has specific recommendations for microwaving the product. Because food in these containers will only heat from the top, it's best to microwave foods only 1-2 inches in depth so food near the bottom will be heated thoroughly before food on top dries and overcooks.

### **General Rules for Safe Use of Aluminum Foil:**

- Use new, smooth foil only. Wrinkled foil can cause arcing (sparks).
- Cover no more than 1/4 of the food with foil.
- Shape the foil smoothly to the food so no edges stick out
- It makes no difference which side of foil (shiny or dull) is facing out.
- Do not place the foil closer than one inch from the oven walls.
- If the microwave oven has metal shelves OR a metal turntable, don't microwave food in foil containers or metal pans, and don't let foil used for shielding touch or be close to the shelves or turntable.
- If you see arcing (sparks), immediately remove the foil shielding; transfer frozen food from foil container to a microwave-safe utensil.

### **How do you determine if a utensil is safe to use in a microwave oven?**

If a utensil is not labeled for microwave use, you can test it before using to make sure it is microwave safe.

Put one cup of tap water in a glass measure. Place the water in the microwave oven along with (but not touching) the utensil to be tested. Microwave on high 1 minute. If the utensil feels warm or hot, it is not microwave safe because it contains metal in the material or glaze. Do not use it. The utensil and/or the bottom of the oven might crack if microwaved.

### How does wattage affect microwave cooking?

The higher the wattage of a microwave oven, the faster it will cook food. So it's important for food safety to know the wattage of your oven when using cooking directions from various sources.

If you don't know the wattage of your microwave oven, try looking on the inside of the oven's door, on the serial number plate on the back of the oven, or in the owner's manual. You can also do a "Time-to-Boil" test to estimate the wattage.

#### "Time-to-Boil" Test

Measure a cup of water in a 2-cup glass measure. Add ice cubes; stir until water is ice cold. Discard ice cubes and pour out any water more than 1 cup. Set the microwave on high 4 minutes, but watch the water through the window to see when it boils.

- If water boils in less than 2 minutes, it is a very high wattage oven 1000 watts or more.
- If water boils in 2 1/2 minutes, it is a high wattage oven about 800 watts or more.
- If water boils in 3 minutes, it is an average wattage oven 650 to 700 watts or more.
- If water boils in more than 3 minutes or not by 4 minutes, it is a slow oven 300 to 500 watts.

Use the minimum cooking time given for high wattage ovens; use the maximum cooking time for slow ovens. The minimum cooking time may need to be reduced for very high wattages.

### Do Microwaves Make Food "Radioactive"?

No. Microwave energy uses a wave length similar to television, radio waves, electric shavers and radar. It does not make food "radioactive." X-rays and nuclear radiation are at the other end of the spectrum and are a million times more powerful.

### Can a microwave oven be used for home canning?

Do not use the microwave for home canning or sterilizing jars. Use a water-bath or pressure canner, and approved canning jars and lids. At one time, "canners" were developed for use in the microwave; however these did not produce a safe product and are no longer manufactured.

### What is "arcing"?

Arcing (pronounced "AR-king") is sparks inside the microwave oven caused when microwaves react to gold paint on dishes, twist ties and other metallic materials.

Some foods such as raw carrots and hot dogs can cause arcing while being microwaved. In hot dogs, this can be due to the uneven mixing of salts and additives. In carrots, it can be due to the minerals in the soil in which they were grown.

Whatever the cause, turn off the oven immediately to end the sparks. Prolonged arcing can damage the oven and/or the utensil. If caught at once, arcing should not damage the oven. Remove the offending utensil or food from the oven and either substitute a microwave-safe utensil or cook the food by other methods.

### What is “erupting”?

Erupting, or violent boiling over, can occur when a liquid (primarily water) heated in a microwave oven becomes hotter than its conventional 212 °F boiling temperature (super-heated). The liquid boils over when instant coffee, tea or gelatin is added to the superheated water. In extremely rare instances, all that is needed to initiate boiling of a superheated liquid is motion. Thus, a superheated cup of water could theoretically erupt violently when it is removed from a microwave oven.

Superheating usually occurs when microwaving water in a very clean vessel — usually just taken from a dishwasher — or when microwaving room temperature water. It also happens because liquids heat with internal “hot spots” so that a temperature higher than 212 °F (the boiling point of water) builds up an inch or two below the surface.

Thus, even though it is extremely unlikely for an eruption to occur in a microwave oven, several precautions can be taken to lessen the potential for a problem:

- Use a vessel with sloping walls, such as a measuring cup.
- Leave a microwavable spoon in the vessel while heating.
- Stir occasionally while heating.
- Add a pinch of instant coffee, a tea bag, or gelatin at the beginning or halfway through heating.
- Consult the oven’s manufacturer or owner’s manual.
- Contact the International Microwave Power Institute, 7076 Drinkard Way, Mechanicsville, VA 23111, (804) 559-6667, Fax (804) 559-4087, [www.impi.org](http://www.impi.org).

### For more information.

## 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)**.

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