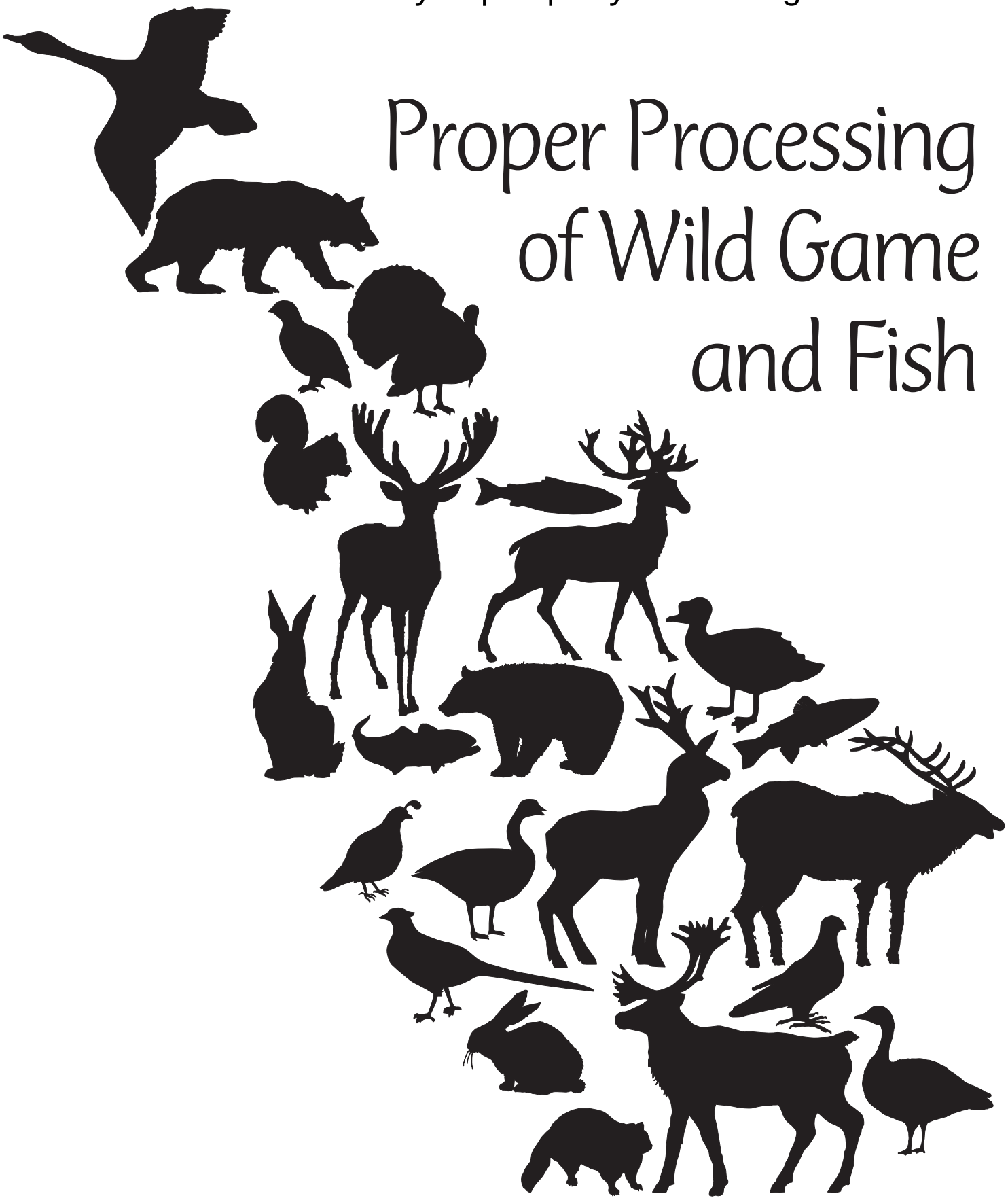
Proper Processing of Wild Game and Fish



PennState Extension

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INTRODUCTION

Hunting and fishing are some of Pennsylvania's most popular outdoor activities. While most outdoors people hunt or fish for sport, many of them also do it to provide food for themselves and their families. The meat from hunted animals, birds, or fish is processed and either prepared for immediate consumption or preserved for later consumption.

Those who field dress animals, fish, and birds and transport them from the field are often unaware of the potential risks associated with foodborne pathogen contamination. As with any perishable meat, raw or undercooked game meat can contain harmful bacteria such as salmonellae and pathogenic strains of *Escherichia coli*. These bacteria, often associated with the gastrointestinal tracts of animals, can cause illness in humans when ingested. Contamination of meat or fish may occur through the initial wound as well as during field dressing, handling, and transport. Bacterial numbers will increase on the meat, especially if held at improper temperatures. If the meat is not properly cooked or preserved, or if cross-contamination occurs, there is an increased risk that these pathogens will be ingested, often resulting in foodborne illness. Therefore, proper handling of game meat or fish from the field or stream to the table is extremely important. This publication contains guidelines and hints to help you make sure the food you are consuming is handled and prepared safely.

THE IMPORTANCE OF TEMPERATURE CONTROL

Bacteria exist everywhere in nature—in the soil, air, water, and our food—and it can grow on that food when the temperature is right because it provides the nutrients and other conditions bacteria need to grow. Temperature control plays a critical role in keeping food safe and is essential for the prevention foodborne illness.

Bacteria grow most rapidly in the range of temperatures between 40°F and 140°F (4°C and 60°C)—in some cases, doubling in number every 20 minutes. This range of temperatures is often called the "temperature danger zone."

Temperatures below 40°F (4°C) will slow the growth of the bacteria but will not kill them. Bacteria capable of causing foodborne illness either do not grow at these refrigerator temperatures or grow very slowly. However, spoilage bacteria, yeasts, and molds will grow and cause the meat or fish to spoil over time. After days of refrigerated storage, meats may develop uncharacteristic odors or colors and/or may become sticky or slimy.

Always use a refrigerator/freezer thermometer to verify that the temperature of the refrigeration unit is below 40°F (4°C).

Properly handled and prepared game meat, birds, or fish stored in a freezer at 0°F (-18°C) will last up to a year or so. Freezing prevents bacterial growth, but it does not kill them. Once thawed, these bacteria can again become active and multiply to levels that may lead to foodborne illness. Therefore, thawed meats should be handled in the same manner as fresh meats. Be sure to thaw frozen meats properly—either in the refrigerator, in a microwave, or if vacuum packaged, under cold, running water, but never at room temperature. Cook the meat quickly after thawing is completed.

When storing and handling meats, preventing cross-contamination is important. Prevent meat juice from dripping onto other food items in the refrigerator and clean all surfaces and utensils that come in contact with the raw meat or its juices with hot, soapy water and rinse well.

Always cook raw game meat, birds, and fish to the proper internal temperature. This internal temperature must be reached or exceeded during baking, roasting, frying, or boiling in order to destroy bacteria that can cause foodborne illness. When roasting meat and poultry, use an oven temperature no lower than 325°F (163°C). Cook ground meats to an internal temperature of at least 160°F (71°C). Cook game bird breast meat to an internal temperature of at least 165°F (74°C). Use a properly calibrated, instant-read thermometer to ensure that all meats have reached the proper internal temperature.

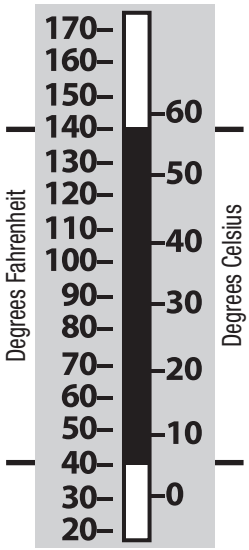
An uncommon but severe parasite that may be associated with bear and wild pigs from North America is *Trichinella spiralis*. The parasite can be inactivated by freezing the raw meat for at least three weeks prior to consumption. Proper cooking also will destroy the parasite. So, bear or wild pig meat should be cooked using the same temperature guidelines as other meats such as venison.

Once cooked, it is important to cool the meat down rapidly and then store it at refrigeration temperatures if the food will not be consumed immediately. Spore-forming bacteria, such as *Clostridium botulinum* and *Clostridium perfringens*, are a risk in cooked meat items that are not properly chilled and stored.

Safe food-handling practices are a good defense against foodborne illness. Because we know how different temperatures affect the growth of bacteria in our food, we can protect ourselves and our families from foodborne illnesses by properly handling, cooking, and storing game meat, birds, or fish at safe

The Temperature Danger Zone

41–140°F (5–60°C)



temperatures.

PROCESSING OF WILD GAME OR FISH

Aging

Aging of meat (also referred to as seasoning, ripening, or conditioning) is the practice of holding carcasses or cuts under low controlled temperature and humidity for several days to enhance flavor, tenderize, and complete curing reactions. Some game meat is aged to enhance flavor and tenderness, which occurs when enzymes break down or degrade complex proteins in the muscle over time (see the graph below). Poultry and fish are seldom aged. The tenderization process stops once meat is frozen and does not resume when the meat is thawed.

Meat from game animals is generally less tender than that of domestic animals because of the exercise wild animals exert in foraging for food and the low-energy diet they consume. Tenderness is related to the age of the animal and to the muscle location in the carcass. The most tender meat comes from young, healthy animals. The condition of the animal immediately before harvest also affects the quality of the meat. For example, if an animal has run a long distance before being killed, its meat may be darker in color (brown to purplish black), sticky, or gummy in texture. The pH of the meat is also higher in these animals because the energy stores in the muscle are depleted, whereas the pH of meat of rested animals is 5.6–5.8. The increase in pH reduces the overall meat quality and increases the potential for bacterial growth.

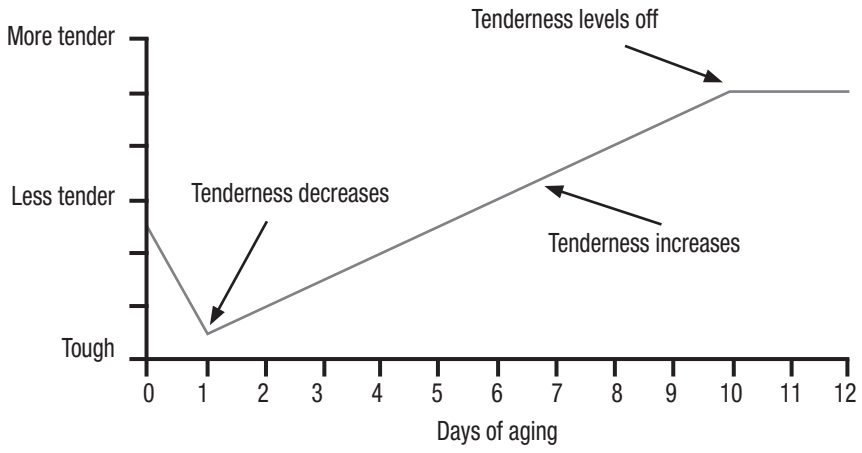
Meat that is to be ground, cured, or made into sausage or bologna does not need to be aged since further processing tenderizes the meat. Seldom, a noticeable difference occurs in tenderness when game meats are aged for prolonged periods. Aging is not recommended for a carcass with little or no fat covering, as the carcass may dry out during the aging process. If you choose to cook your game by braising, roasting, or stewing, then aging is not necessary since moist heat cooking also tenderizes the meat. It is possible to age meat packaged in vacuum bags and stored under refrigeration. One option is to select those cuts that will be cooked by dry heat (i.e., backstrap/loin or sirloin muscles) and age them while others may go to the meat grinder.

If you will be aging a carcass at home or a camp, leave the hide on to protect against excessive dehydration, discoloration, and contamination from dirt, insects, leaves, bacteria, mold, etc. The tenderization benefit of aging will cease if the carcass freezes. State laws require that the hide be removed before processing at commercial processors. If you age at home, remember to do so in clean, cool, well-ventilated areas free from gas, oil, or paint odors, as the meat may absorb them.

Aging for 5–7 days should improve tenderness without undue spoilage. It is extremely important, however, to age game carcasses or meat under refrigerated conditions [at a temperature below 40°F (4°C)]. Although the action of the tenderization enzymes is much faster at warmer temperatures [greater than 40°F (4°C)], spoilage occurs more quickly and bacteria of public health concern (*Salmonella*, pathogenic *E. coli*) also grow much faster. Aging at warmer temperatures can present both meat quality defects and health hazards. "Off" odors associated with aged carcasses generally are indicative of microbial growth. Under these circumstances, it is advised that the meat be discarded. Even if cooked, the meat will be objectionable and may present health hazards.

Aging birds is a matter of personal preference. If you decide to age, hang gutted birds by the feet in a cool [<40°F (4°C)], dry, airy place for no more than 2–3 days. You can dust feathers with charcoal and/or cover with cheesecloth to protect from insects.

Relationship between meat tenderness and aging.



Cutting/Processing

If you intend to use a meat processor, you should schedule arrangements with a licensed, reputable establishment ahead of time to ensure your carcass will be handled, processed, and stored properly. It is also your responsibility to dress and remove the hide of the carcass before entering the processing or refrigerated areas of the licensed establishment. Some custom processors may allow you to deliver hide-on carcasses and will remove it for a fee. Processors must follow several regulations in Pennsylvania:

- Any game carcasses stored in licensed establishments must be contained and handled so that there is complete separation from domestic meat, poultry, and meat products.
- The licensed establishment must

provide the USDA a written list of days and times when game carcasses are processed.

- Any equipment used to process game carcasses or meat must be thoroughly cleaned and sanitized before it can be used for processing domestic meat, poultry, and meat products.

Most meat processors will do the job of cutting and wrapping your meat for the freezer. It's a good idea to let the processor know what cuts you want, the thickness of steaks, etc. Some processors also will make boneless cuts. Although they are more expensive, you'll end up with higher-quality cuts that are easier to store and serve.

If you cut the carcass yourself, make sure you have a clean, roomy, well-ventilated place to work, as well as a clean, sharp knife and saw. Have boiling water available to clean your knife, as it will be dirtied as you cut. Be sure to separate entire muscles, keep the knife close to the bone, and cut across the grain when making roasts and steaks. Boneless cuts will use up less space in a freezer and are easier to wrap and carve. Specific cuts and areas for cutting large game animals are illustrated below.

The cutting method for large game carcasses (Field, 1983) is as follows:

A to B. Remove the neck and shoulder. You may want to bone out the muscle for ground meat.

C to D. Separate the shoulder from the rib between the fifth and sixth ribs (counting from front of carcass).

E to D. Remove the brisket and foreshank just above the elbow joint. Arm and blade roasts may be cut and trimmed. Portions of the shoulder not suitable for roasts and foreshank may be boned for ground meat.

F to G. Cut the leg from the loin, leaving one vertebra on the leg. Sirloin steaks and bone-in leg roasts are made from these cuts. The hind shank and trimmings may be boned and used for ground meat.

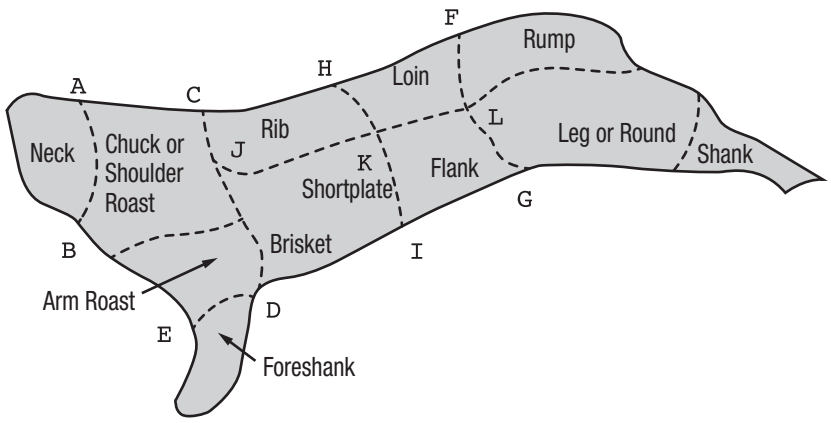
H to I. Separate the rib and shortplate from the flank and loin by cutting between the twelfth and thirteenth ribs.

J to K. The rib is separated from the breast by a ½-inch ventral cut to the blade bone on a line parallel to the back. The flank and breast may be boned for ground meat; however, this is advised against since it exposes meat that may have been contaminated during dressing. Additionally, it is not advised to bone out ribs for the same reason.

K to L. The flank is removed from the short loin by cutting next to the tenderloin. The rib and loin may be cut into steaks.

Once the cuts are made, you can further process the muscles to steaks, roasts, sausage, bologna, etc.

Location of various cuts on a carcass.



Curing

Curing is defined as adding salt, salt brine, nitrites, and sometimes sugar, spices, and other ingredients to a meat, poultry, or fish product. Game meats, birds, or fish are cured for three main reasons: preservation, flavor, and color. Only properly butchered and thoroughly cooled meats should be cured.

To preserve meat and poultry, you must inactivate and destroy the undesirable microorganisms on the meat surfaces that cause spoilage and foodborne illnesses. Many techniques help in this process, including smoking, cooking, drying, chilling, and adding cure ingredients. One of the most effective is introducing salt into the meat. The salt curing process requires careful temperature control. The temperature must be warm enough to allow the salt to penetrate the meat, but cold enough [under 41°F (5°C)] to prevent decomposition. The resistance of different types of bacteria to salt varies widely. The growth of some bacteria (e.g., *Salmonella*) is inhibited by salt concentrations as low as 3 percent, whereas other types (e.g., *Staphylococcus*) are able to survive in much higher concentrations. Fortunately, low salt concentrations inhibit the growth of many of the undesirable organisms normally found in cured meat and poultry products.

Nitrite, another compound associated with curing, is a highly reactive chemical that interacts with several of the components in meat, including pigments, protein, and fat. Nitrite also provides an important antimicrobial effect, preventing the outgrowth of *Clostridium botulinum* and the formation of its deadly toxin. To date, no other single chemical additive can perform all the functions of nitrite in cured meat. Nitrites are used in very low levels in cured meat products and therefore do not pose a health risk.

The flavor of cured meats is thought to be a composite of the flavors of the curing agents and those developed by bacterial and

enzymatic action. Sugar is added to many cured products; however, it is a minor part of the composite flavor. It serves mostly to reduce the harshness of the tremendous amount of salt in cured meat and poultry. Sugar also plays an important role as food for the flavor-producing bacteria of meat during long curing processes. Another probable cause of the characteristic flavor of cured meat, poultry, and fish products is the effectiveness of nitrite in retarding lipid oxidation and the development of "off" flavors.

Smoking also gives the product a characteristic flavor, which can be varied slightly with cure and types of smoke. In addition to smoke generated from hardwoods or liquid smoke, a smoke-flavoring solution can be sprayed onto meat food products during the cooking process.

Developing and maintaining a stable red color is very important in cured and smoked-meat operations. Sodium or potassium nitrate (also known as saltpeter or saltpetre) or nitrite, the cure agent used to process cured meats, is responsible for the development of this color. Nitrate is used sometimes as a source of nitrite. The further reduction of nitrite to nitric oxide, which reacts with myoglobin (muscle pigment) to produce the cured color, is affected by several environmental conditions such as temperature, moisture content, salt content, and pH. The time required for this color to develop may be shortened with the use of cure accelerators such as ascorbic acid or a derivative, erythorbic acid or a derivative, sodium ascorbate, and sodium erythorbate. Cure accelerators speed up the chemical conversion of nitrous acid to nitric oxide, helping to ensure a complete cure reaction. They also serve as oxygen scavengers that prevent the color of cured meat from fading in the presence of sunlight and oxygen.

Curing Methods for Game

There are several general methods of curing, with a number of modifications for each method. These methods include pickle curing, dry curing, dry salt curing, or application of curing solutions by osmosis, stitch pump, spray pump, artery pump, and machine pump.

Pickle Curing

A typical pickle curing solution could include water and salt (called a "plain" or "salt" pickle); water, salt, nitrate, and/or nitrite; or water, salt, nitrate, and/or nitrite to which sugar has been added (a "sweet" pickle). Other ingredients could be added to enhance flavor. A basic brine solution generally consists of 1 pound of brown sugar, 2 pounds of uniodized salt, and 3 gallons of water. Use a noncorrosive container to hold the brine and meat during the curing process. Wood, crockery, stainless steel, or plastic containers work well. Place the meat in the container and pour the brine over it until it is covered. If the meat floats, you may have to place a weight on it to keep it submerged. Turn the meat in the brine periodically to cover all surfaces.

Dry Curing

Dry curing involves the rubbing and packing of meat in salt and other compounds for considerable periods of time. Dry curing materials might include salt alone; salt, nitrate, and/or nitrite; or salt, nitrate, and/or nitrite with sugar. One example of a dry cure is dry sugar cure:

Dry Sugar Curing

A full concentration of the following ingredients (the "8–3–2–1 formula") is applied directly to the meat surface:

8 pounds table or curing salt

3 pounds cane sugar

2 ounces sodium or potassium nitrate (saltpeter)

1 ounce sodium nitrite

Use 1 ounce of 8-3-2-1 formula for each pound of meat. Place rubbed meats in boxes under refrigerated [<40°F (4°C)] conditions. Cure 7 days per inch of meat thickness.

Dry Salt Curing

Another modification of the dry curing method, commonly referred to as dry salt curing, involves salt only or salt plus nitrate. Just before being covered with the dry mix, the meat may be momentarily moistened to facilitate penetration of the salt into the muscle.

Injecting or Pumping

The purpose of injecting or pumping is to distribute pickle ingredients throughout the interior of the meat to cure it from the inside out as well as from the outside in. This process protects the meat against spoilage and provides a more even curing. Once the brine solution is applied by any of the methods described below, curing should take place in a refrigerator or cool room at temperatures less than 35°F (2°C). Rearrange the meat at least once during the curing process to ensure even distribution of the cure into the product. Do not recycle the brine because of the possibility of bacterial growth over time.

Five general methods are used to apply curing solutions to meat and poultry cuts:

1. Osmosis involves covering the meat cuts with dry cure or completely submerging them in a curing solution for an extended period of time. Using this method, the brine soaks the meat approximately ½ inch per 24 hours. Thus, the cure does not penetrate deeply into the meat with this method. For pieces of game meat or birds more than 2 inches thick, pumping with brine is advised (see below). Cure ¼- to ½-inch-thick slices or slabs for at least 24 hours.
2. The stitch method involves injecting curing solution deep into the muscles with a single-orifice needle. With this method, you can quickly get deep penetration of the solution into the product. Start by scrubbing the pump in warm, soapy water and rinsing it. Then, to keep the pump sanitary while

pumping meat, do not touch the needle with your hands or lay it down. When not in use, the pump needle should be placed end-down in the container that holds the pickle. To use it, draw the pump full of pickle and insert the needle all the way into the meat. Push with slow, even pressure. As pickle is forced into the meat, draw the pump toward you to distribute the pickle as evenly as possible. Always fill the pump full of pickle to prevent air pockets. The meat will bulge a little, and a small amount of pickle will run out of it when the pump is withdrawn. To stop this, pinch the needle holes together with your thumb and forefinger for a few seconds. Use three or four pumpfuls of pickle for legs and shoulders that weigh 10–15 pounds and five or six pumpfuls for those that weigh 15–25 pounds.

3. Spray pumping is a variation of the stitch method that uses a needle with many orifices to allow for more uniform distribution of the pickle throughout the product.
4. Artery pumping is the introduction of the curing solution into the natural circulatory system of the muscle. Force a pickle solution into the femoral artery by means of a small needle attached to a hose and pump that exerts 40–50 pounds of pressure. Artery-pumped meats can be rubbed with a dry cure mix or placed in a pickle solution for 5–7 days to complete the curing process.
5. Machine pumping uses a machine with many needles for injecting product with curing solutions. This method is considered efficient and economical and is used primarily for curing large volumes of meat.

Curing ingredients such as Morton's Quick Cure can be found in many rural grocery stores or ordered through your local supermarket. Most outdoor catalogs also carry seasoning and curing products, or you can purchase these ingredients through your local butcher shop.

After the meat, poultry, or fish product is cured, soak it in cold (<40°F) water for 30 minutes to 2 hours. This process is known as clearing. It removes excess salt from the surface and equalizes the salt content in the meat. The thicker the meat, the longer the clearing time should be. After clearing, thoroughly drain the cured product. At this point, the cured product is usually cooked, either with or without smoke.

Smoking

Smoking is cooking food indirectly in the presence of a fire, though the food's proximity to the heat source can vary. It can be done in a covered grill if a pan of water is placed beneath the meat on the grill; meats also can be smoked in a "smoker," an outdoor cooker especially designed for smoking foods. Smoking is much slower than grilling, so less-tender meats benefit from this method, and a natural smoke flavoring permeates the meat.

Depending on the method, some products may be cooked and smoked simultaneously, smoked and dried without cooking, or cooked without smoking. Smoke may be produced by burning wood chips or using an approved liquid smoke preparation. Liquid smoke preparations also may be substituted for smoke flavor by adding them directly onto the product in lieu of using a smokehouse or another type of smoking vessel.

It is important to use a properly calibrated thermometer to ensure that the food has reached a safe internal temperature.

Smoking Large Game

Smoking adds flavor to large cuts of meat and keeps them tender. It can require up to 8 hours, depending on the meat's size and dimensions and the outdoor air temperature. Use high-quality charcoal to build a hot fire. Pile about 50 briquettes in the center and when they are covered with gray ash, push them into two piles. Center a pan of water between the piles.

Place the meat on the grill over the water pan, close the lid, and keep the grill vents open. Add about 10 briquettes every hour to maintain the temperature in the smoker to between 225°F and 300°F (107°C and 149°C) for safety. Smoke until the internal temperature of the meat reaches a minimum of 165°F (74°C). Use a properly calibrated thermometer to check the temperature in the thickest part of the meat.

Wood chips such as mesquite can be used for additional flavor. Using dry chips at the start creates a fast smoke; wet them later for sustained heat. Hardwoods such as hickory, maple, chokecherry, oak, or apple are best for smoking. Never use a soft wood such as pine because the resin tars will produce "off" flavors. Be sure to keep water in the pan to ensure 80–90 percent humidity, which will prevent weight loss and drying of the meat.

Smoking Fish

Note: The following information is recommended for salmon, rockfish, and flatfish (sole, cod, flounder). Safe processing times for other smoked fish have not been developed.

Whether caught or purchased, fish can be smoked successfully at home; though fish smoked without proper salting and cooking can cause food poisoning. The bacteria that cause botulism food poisoning could start to grow after 2-3 weeks of refrigeration. For long-term storage, smoked fish must be frozen or canned. Canning is preferred by many who smoke fish at home, and the fish must be processed in a pressure canner to destroy *Clostridium botulinum* spores. Unfortunately, the length of processing time needed to guarantee safety can affect the quality of home-canned smoked fish. Canning tends to dry the fish, darken the color, and intensify the smoked flavor; reducing the processing time to lessen these undesirable quality changes is unsafe. Instead, the smok-

ing procedure must be modified.

For best quality, fish that will be canned should be smoked for a shorter time than ready-to-eat products. Lightly smoked fish must be promptly canned to ensure that it will be safe and of top quality. It should not be eaten before it is canned, as some bacteria survive the short smoking process and are destroyed only during canning. If you plan to can your fish, the following smoking procedure will give the best results.

Preparing Fish for Smoking

Different species of fish require different preparation techniques. Salmon usually are prepared by removing the backbone and splitting them. Bones usually are not removed. Rockfish and flatfish such as sole, cod, and flounder should be filleted.

You'll need about ⅔ pound of smoked fish for each 1-pint canning jar. About 1½–3 pounds of whole fish will yield this amount of smoked fish, depending on the amount of waste removed such as the head, tail, fins, and entrails. Be sure to use good-quality, firm fish. Smoking and canning won't improve poor quality! Keep fish refrigerated or on ice before smoking.

Clean all fish thoroughly to remove blood, slime, and bacteria. Keep fish cold at all times, but do not refreeze. Remove scales and skin, if desired. Cut prepared fish into pieces that will fit vertically into pint canning jars, about 1 inch shorter than the jar height. Salt will be more uniformly absorbed if pieces are of a similar size.

Salting

Soaking fish in a strong salt solution (brine) before smoking will give a good surface texture and retard surface spoilage. For each 2–3 pounds of prepared fish, dissolve 1 cup of salt in 7 cups of water. Soak thin pieces of fish (½ inch at the thickest point) for about 5–10 minutes. Larger, thicker pieces of fish (over ½ inch thick) will need 30–45 minutes of soaking.

Note: If you want less salt in the finished product, reduce the brining time and smoke for no longer than 1 hour. Be sure to can lower-salt fish immediately after smoking to ensure safety.

Smoking for Canning

Because smoke alone is not an effective preservative under most conditions, small factory-made electric or charcoal smokers are suitable only for smoking fish that also will be canned. Lightly smoked fish for canning doesn't have to reach the internal temperature required for ready-to-eat products, which is 160°F (71°C) for at least 30 minutes.

Smoke the amount of fish that you plan to can that same day. Smoke fish for up to 2 hours, depending on the level of smoke flavor desired. Since lightly smoked fish isn't safe to eat, don't taste it to see if it's done. The best way to judge doneness is to measure weight loss. Weight is lost as moisture evaporates during smoking.

A 10 percent weight loss yields a moist, good-quality product after canning. The moisture loss in most ready-to-eat smoked fish is generally 20–30 percent. Lightly smoked oily fish such as black cod will seem very moist because of their higher fat content. You can measure weight loss easily with a kitchen scale. Calculate the percentage of loss by comparing the difference in the weight of one piece of raw fish before and after smoking. Do the following:

1. Weigh a piece of fish before smoking (A).
2. Weigh the same piece of fish after smoking (B).
3. Subtract the ending weight (B) from the beginning weight (A) to calculate the weight lost (C).
4. Divide the weight lost (C) by the beginning weight (A) to get the result (D).
5. Multiply the result (D) by 100 to calculate the percent of weight loss (E).

For example:

8 ounces beginning weight (A)

$$\frac{-7 \text{ ounces ending weight (B)} =}{1 \text{ ounce weight lost (C)}}$$

1 ounce (C) ÷ 8 ounces (A) = 0.125 (D)

0.125 (D) x 100 = 12.5 percent (E)

This 12.5 percent weight loss would yield a fairly moist piece of smoked fish after canning. A 20 to 30 percent weight loss would be too dry after canning.

Note: If your smoked fish cannot be processed immediately, refrigerate it for processing later that day. If canning will be delayed for more than 1 day, freeze the fish. Frozen smoked fish must be thawed to refrigerator temperature before canning. Thaw fish in the refrigerator, not on the counter.

Smoking Game Birds

Smoking can add new flavor, convenience, and increased shelf life to your game meat. Game birds can be processed in a salt brine, in which the salt has been smoked or to which liquid smoke has been added, and cooked in a home oven without a special smokehouse. Using another method, the meat is cured in a sugar and salt brine and then smoked using hardwoods. While more cumbersome, the smoke flavor penetrates the meat, resulting in a better flavor.

Heat the carcass at 140°F (60°C) for 30 minutes, and then turn on the smoke, increase smokehouse humidity by placing pans of water over the heat source, and heat at 150°F (66°C) for 1 hour. Turn off the smoke and heat at 170°F (77°C) for 2 hours followed by a 185–200°F (85–95°C) smokehouse air temperature until the internal temperature reaches 165°F (74°C), as measured by a meat thermometer.

Smoking will give the game birds a light brown color and smoky aroma. After smoking, the meat must be refrigerated at temperatures lower than 40°F (4°C). Smoked birds may keep for up to 3–4 weeks in a refrigerator. If the product will not be consumed immediately, freeze for up to 6 months. Because of the rancidity and stale, "off" flavors associated with poultry fat, it is not advised to store game birds much longer than

6 months.

To serve your smoked product, reheat in a conventional oven at 275–325°F (135–163°C) for 15–20 minutes per pound of product. Cover the meat with foil to retain the moisture and eliminate the need for basting.

Canning

Only good-quality properly cleaned and cooled game or fish should be canned. To ensure safety of canned meats or fish, all jars or cans must be processed in the pressure canner at the correct pressure to achieve a sufficiently high temperature for a long enough time to kill all bacteria that cause spoilage or food poisoning. Penn State Extension's "Let's Preserve: Home Canning Basics" (go to: **https://extension.psu.edu/lets-preserve-basics-of-home-canning**) fact sheet provides instructions on using a pressure canner. Large game animals are canned like beef, and small game animals and birds like poultry. Either type of meat can be raw packed or hot packed.

Before starting any canning projects, it is advisable to (1) have your local extension office check and calibrate your dial gauge; (2) use only quality canning equipment: standard glass mason-type jars and a two-piece flat lid and screw band; and (3) follow the manufacturer's directions for safe operation of the canner. For detailed canning instructions, consult the USDA publication *Complete Guide to Home Canning: Guide 5, Preparing and Canning Poultry, Red Meats, and Seafoods* (2015 revision). Go to: **https://nchfp.uga.edu/publications/usda/GUIDE05_HomeCan_rev0715.pdf** or Penn State Extension's "Let's Preserve: Meat and Poultry" fact sheet **https://extension.psu.edu/lets-preserve-meat-and-poultry**.

Canning Small Game Animals and Birds

Choose freshly killed and dressed healthy animals or birds. Soak dressed meat for 1 hour in cold water containing 1 tablespoon of salt per quart, and then rinse. Remove excess fat. Cut meat into suitable sizes for canning. Can with or without bone.

For hot pack, boil, steam, or bake meat until about two-thirds done. Add 1 teaspoon salt per quart, if desired. Fill jars with cooked meat pieces and hot broth, tomato juice, or water, leaving 1¼ inch of headspace.

Table 1. Recommended Process Time for Canning Strips, Cubes, or Chunks of Meat in a Dial-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:			
Style of Pack	*Jar Size*	*Time (min)*	*0–2,000 ft*	*2,001–4,000 ft*	*4,001–6,000 ft*	*6,001–8,000 ft*
Hot or Raw	Pints	75	11 lb	12 lb	13 lb	14 lb
	Quarts	90	11	12	13	14

Source: *USDA Complete Guide to Home Canning* (2015)

Table 2. Recommended Process Time for Canning Strips, Cubes, or Chunks of Meat in a Weighted-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:	
Style of Pack	*Jar Size*	*Time (min)*	*0–1,000 ft*	*Above 1,000 ft*
Hot or Raw	Pints	75	10 lb	15 lb
	Quarts	90	10	15

Source: *USDA Complete Guide to Home Canning* (2015)

Table 3. Recommended Process Time for Canning Ground or Chopped Meat in a Dial-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:			
Style of Pack	*Jar Size*	*Time (min)*	*0–2,000 ft*	*2,001–4,000 ft*	*4,001–6,000 ft*	*6,001–8,000 ft*
Hot	Pints	75	11 lb	12 lb	13 lb	14 lb
	Quarts	90	11	12	13	14

Source: *USDA Complete Guide to Home Canning* (2015)

Table 4. Recommended Process Time for Canning Ground or Chopped Meat in a Weighted-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:	
Style of Pack	*Jar Size*	*Time (min)*	*0–1,000 ft*	*Above 1,000 ft*
Hot	Pints	75	10 lb	15 lb
	Quarts	90	10	15

Source: *USDA Complete Guide to Home Canning* (2015)

For raw pack, add 1 teaspoon salt per quart, if desired. Fill jars loosely with raw meat pieces, leaving 1¼ inch of headspace. Do not add liquid.

Follow the recommendations in the tables below for additional information about canning meat safely.

Canning Large Game Animals (Strips, Cubes, or Chunks)

Choose high-quality chilled meat. Remove excess fat. Soak strong-flavored wild meats for 1 hour in brine water containing 1 tablespoon of salt per quart. Rinse. Remove large bones.

For hot pack, precook meat until rare by roasting, stewing, or browning in a small amount of fat. Add 1 teaspoon of salt per quart, if desired. Fill jars with pieces and add boiling broth, meat drippings, water, or tomato juice, leaving 1 inch of headspace.

For raw pack, add 1 teaspoon of salt per quart, if desired. Fill jars with raw meat pieces, leaving 1 inch of headspace. Do not add liquid.

Adjust lids and process following the recommendations in the tables below, according to the canning method used.

Canning Ground or Chopped Meat

Choose fresh, chilled meat. With venison, add one part high-quality pork fat to three or four parts venison before grinding. Use freshly made sausage, seasoned with salt and cayenne pepper (sage may cause a bitter "off" flavor). Shape chopped meat into patties or balls or cut case sausage into 3- to 4-inch links. Cook until lightly browned. Ground meat may be sautéed without shaping. Remove excess fat. Fill jars with pieces. Add boiling meat broth, tomato juice, or water, leaving 1 inch of headspace. Add 1 teaspoon of salt per quart to the jars, if desired.

Adjust lids and process following the recommendations in the tables below, according to the canning method used.

Canning Fresh Fish

Although freezing is the easiest way to preserve fish, canning does offer some advantages. Canning heat inactivates enzymes that degrade muscle or flesh; precooked canned foods are ready to eat; and canning avoids the problem of freezer burn. The only safe way to process fish is in a pressure canner. Follow recommended canning procedures carefully and always use pint jars. Fish can be canned in quart jars, but the process for operating the pressure canner while processing quart jars is different from pint jars and directions must be followed exactly for a safe product. Follow the directions in the *USDA Complete Guide to Home Canning: Guide 5, Preparing and Can-*

Table 5. Recommended Process Time for Canning Fish in a Dial-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:			
Style of Pack	*Jar Size*	*Time (min)*	*0–2,000 ft*	*2,001–4,000 ft*	*4,001–6,000 ft*	*6,001–8,000 ft*
Raw	Pints	100	11 lb	12 lb	13 lb	14 lb

Source: *USDA Complete Guide to Home Canning* (2015)

Table 6. Recommended Process Time for Canning Fish in a Weighted-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:	
Style of Pack	*Jar Size*	*Time (min)*	*0–1,000 ft*	*Above 1,000 ft*
Raw	Pints	100	10 lb	15 lb

Source: *USDA Complete Guide to Home Canning* (2015)

Table 7. Recommended Process Time for Canning Smoked Fish in a Dial-Gauge Pressure Canner (see special directions for filling the pressure canner above)

		Canner Pressure (PSI) at altitudes of:			
Jar Size	*Time (min)*	*0–2,000 ft*	*2,001–4,000 ft*	*4,001–6,000 ft*	*6,001–8,000 ft*
Pints	110	11 lb	12 lb	13 lb	14 lb

Source: *USDA Complete Guide to Home Canning* (2015)

Table 8. Recommended Process Time for Canning Smoked Fish in a Weighted-Gauge Pressure Canner (see special directions for filling the pressure canner above)

		Canner Pressure (PSI) at altitudes of:	
Jar Size	*Time (min)*	*0–1,000 ft*	*Above 1,000 ft*
Pints	110	11 lb	15 lb

Source: *USDA Complete Guide to Home Canning* (2015)

ning Poultry, Red Meats, and Seafoods (2015). Fish may be canned with its bones, which adds to the flavor and nutritive value of the product. To safely can fish that has been frozen, thaw it first in a refrigerator and can promptly.

Eviscerate fish within 2 hours after they are caught. Keep cleaned fish on ice until ready to can. Remove head, tail, fins, and scales. Wash and remove all blood. Split fish lengthwise, if desired. Cut cleaned fish into three ½-inch lengths. Fill pint jars with the skin side of the fish next to the glass, leaving 1 inch of headspace. Add one teaspoon of salt per pint, if desired. Do not add liquid. Adjust lids and process according to the canning timetables for fish provided below.

Note: Glasslike crystals of magnesium ammonium phosphate sometimes form in canned salmon. There is no way for the home canner to prevent these crystals from forming, but they usually dissolve when heated and are safe to eat.

Canning Smoked Fish

Note: The USDA recommends that only lightly smoked salmon, rockfish, and flatfish such as sole, cod, and flounder be canned. Safe canning recipes for other smoked fish have not been determined; therefore, these fish should be frozen.

Use a 16- to 22-quart pressure canner. Do not use quart jars or tin cans. Thaw frozen smoked fish in the refrigerator until no ice crystals are present. Cut fish into proper sizes to fit into pint canning jars, leaving 1 inch of headspace. Do not add liquid. Process according to the canning timetables for smoked fish provided below. The directions for filling the pressure canner to process smoked fish are different from those for other pressure canning, so please read the following directions carefully for safety of the canned fish. When you are ready to process your jars of smoked fish, measure 4 quarts (16 cups) of cool tap water and pour into the pressure canner. (Note: The water level probably will reach the screw bands of pint jars.) Do *not* decrease the amount of water or heat the water before processing begins. Place prepared, closed jars on the rack in the bottom of the canner, and proceed as usual with pressure canning instructions; or refer to the 2015 revised edition of the USDA publication *Complete Guide to Home Canning: Guide 5, Preparing and Canning Poultry, Red Meats, and Seafood.*

Canning Rabbit

Choose freshly killed and dressed, healthy animals. Dressed rabbits should be chilled for 6–12 hours before canning, soaked for 1 hour in water containing 1 tablespoon of salt per quart, and then rinsed. Remove excess fat. Cut the rabbit into suitable sizes for canning. Can with or without bones.

For hot pack, boil, steam, or bake meat until about two-thirds done. Add 1 teaspoon salt per quart to the jar, if desired. Fill jars with pieces and hot broth, leaving 1¼ inch of headspace. For raw pack, add 1 teaspoon salt per quart, if desired. Fill jars loosely with raw meat pieces, leaving 1¼ inch of headspace. Do not add liquid.

Adjust lids and process following the recommendations in the tables below, according to the can-

Table 9. Recommended Process Time for Rabbit in a Dial-Gauge Pressure Canner

			Canner Pressure (PSI) at altitudes of:			
Style of Pack	*Jar Size*	*Time (min)*	*0–2,000 ft*	*2,001–4,000 ft*	*4,001–6,000 ft*	*6,001–8,000 ft*
Without Bones:						
Hot or Raw	Pints	75	11 lb	12 lb	13 lb	14 lb
	Quarts	90	11	12	13	14
With Bones:						
Hot or Raw	Pints	65	11 lb	12 lb	13 lb	14 lb
	Quarts	75	11	12	13	14

Source: *USDA Complete Guide to Home Canning* (2015)

Table 10. Recommended Process Time for Rabbit in a Weighted-Gauge Pressure Canner

			Canner Pressure (PSI) at Altitudes of:	
Style of Pack	*Jar Size*	*Time (min)*	*0–1,000 ft*	*Above 1,000 ft*
Without Bones:				
Hot or Raw	Pints	75	10 lb	15 lb
	Quarts	90	10	15
With Bones:				
Hot or Raw	Pints	65	10 lb	15 lb
	Quarts	75	10	15

Source: *USDA Complete Guide to Home Canning* (2015)

ning method used.

Jerky

Drying is the world's oldest and most common method of food preservation. Canning technology is less than 200 years old, and freezing became practical only during the twentieth century when electricity became widely available. Drying technology is both simple and readily available to most of the world's cultures. Jerky is a food known at least since ancient Egypt. Humans made jerky from the meat of animals that were too big to eat all at once, such as bear, buffalo, or whales. North American Indians mixed ground dried meat with dried fruit or suet to make "pemmican." "Biltong" is dried meat or game eaten in many African countries. Our word "jerky" came from the Spanish word "charque."

Removing moisture from food prevents enzymes from contacting or reacting with it. Whether these enzymes are bacterial, fungal, or naturally occurring, preventing their action preserves the food. Illnesses caused by *Salmonella* and *E. coli* O157:H7 in homemade jerky have raised questions about the safety of traditional drying methods for making beef and venison jerky. If improperly cooked, homemade jerky may contain bacteria that can result in severe, life-threatening illness and possibly death.

Simply drying meat may not result in a safe product. In 1995, a *Salmonella* outbreak caused by jerky affected 93 people in New Mexico. Although the product had been dried at 140°F (60°C) for 3 hours and held at 115°F (46°C) for 19 hours, the jerky (beef) had not been heated to 160°F (71°C), thereby allowing the bacterium to survive. Another jerky outbreak occurred in Oregon in 1995, affecting 11 people with *E. coli* O157:H7. The jerky from this outbreak had been dried to 124–135°F (51– 57°C) for 12–18 hours, but not to 160°F (71°C). These outbreaks have raised concern about drying methods used to make jerky at home.

The USDA's current recommendation for making jerky safely is to heat meat to 160°F (71°C) and poultry to 165°F (74°C) before the dehydrating process. This step ensures that any bacteria present will be destroyed by wet heat. But most dehydrator instructions do not include this step, and a dehydrator may not reach temperatures high enough to heat meat to 160°F (71°C). Thus, the meat must be cooked first by baking or simmering before being placed in the dehydrator. Using the dehydrator alone will inactivate microorganisms but not kill them. The right conditions of heat and moisture may cause the microorganisms to become active without the consumer being aware of a potentially dangerous situation. After heating the meat to 160°F (71°C) and poultry to 165°F (74°C), maintain a constant dehydrator temperature of between 130–140°F (54–63°C) during the drying process. This is important because the process must be fast enough to dry food before it spoils, and it must remove enough water to prevent microorganisms from growing.

The following are additional recommendations for making jerky at home:

- Always wash hands thoroughly with soap and water before and after working with meat products.
- Use clean equipment and utensils.
- Keep meat refrigerated at 40°F (4°C) or slightly below; use or freeze ground beef and poultry within 2 days; whole red meats, within 3 to 5 days.
- Defrost frozen meat in the refrigerator, not on the kitchen counter.
- Marinate meat in the refrigerator. Don't save marinade for re-use. Marinades are used to tenderize and flavor the jerky before dehydrating it.
- Steam, boil, or roast meat to 160°F (71°C) and poultry to 165°F (74°C), as measured with a properly calibrated thermometer, before dehydrating it.
- Dry meats in a food dehydrator that has an adjustable temperature dial and will maintain a temperature of at least 130–140°F (54– 60°C) throughout the drying process.

Baking Jerky in an Oven

Place the jerky on cake racks placed on baking sheets, and bake in the oven at 325°F (163°C). Check the internal temperature using a properly calibrated thermometer to make sure meat has reached 160°F (71°C) and poultry 165°F (74°C). Proceed with the directions for drying jerky in a dehydrator (adjustments in the listed length of time to dry will be required), or dry in the oven using the following guidelines.

The temperature of the oven should be 170°F (77°C) or higher and the door should be propped open 2–6 inches. Circulation can be improved by placing a fan outside the oven near the door. Dry until a test piece cracks but does not break when it is bent (5–6 hours). Pat off any beads of oil with absorbent toweling and cool. Remove strips from the racks. Cool. Package and store in a cool, dry place.

Simmering Jerky in a Marinade

Pre-freeze meat to be made into jerky so it will be easier to slice. Cut partially thawed meat into long, ¼-inch-thick slices. For tender jerky, cut at right angles to long muscles (across the grain). Remove as much fat from the slices as possible to prevent "off" flavors.

Prepare 2–3 cups of your favorite marinade and bring it to a rolling boil over medium heat. Add a few meat strips, making sure the marinade covers them. Reheat to a full boil. (Note: It is not advised to presoak the strips in marinade. Putting unmarinated strips into boiling marinade minimizes any cooked flavors and maintains the safety of the marinade.) Remove the pan from the heat source. Remove the strips from the hot marinade and place them in a single, nonoverlapping layer on drying racks.

Dry the strips at 140–150°F (60–66°C) in a dehydrator, oven, or smoker. Test for doneness by letting a piece cool. Strips should crack but not break when bent and should

not contain any moist or underdone spots. Refrigerate the strips overnight. Check again for doneness. If necessary, dry strips further.

Poultry Jerky

Cut the breast meat into thin strips (¼ inch think and 1 inch wide). Cure the strips for 24 hours in brine solution and hold at <40°F (4°C). Rinse and soak the strips in cold water for 30 minutes, drain, and arrange one layer thick on a cookie sheet. Place the meat in an oven at 325°F (163°C) for 1 hour. Using a properly calibrated thermometer, make sure the meat has reached an internal temperature of 165°F (74°C). Reduce the oven temperature and heat until the meat exhibits the desired dryness. Use any jerky within one week; otherwise, freeze it to prevent rancidity.

Sausage Making

Sausages are defined as chopped or ground meat that is blended with spices or other seasonings and stuffed in natural or manufactured casings. There are several different types of sausages, including fresh sausage, cooked smoked sausage, or dry or semi-dry sausage. There are several recommendations for making sausage from game meats:

- Wash your hands with soap and water before working with meats, after changing tasks, and when finished.
- Start with clean equipment—sanitize surfaces with a solution of 1 tablespoon chlorine bleach per gallon of water.
- Select only fresh, high-quality meat and other ingredients (spice, cure, etc.).
- If using frozen meat, thaw in refrigerator or cooler.
- Select the proper lean-to-fat ratio to ensure good texture and binding properties.
- Use cure ingredients (sodium nitrite) purchased from a reputable source. Sodium nitrite will give sausage the characteristic pink color, improve flavor, and inhibit growth of *Clostridium botulinum*.
- Keep the temperature of the meat as cold as possible [<40°F (4°C)] during grinding and mixing.
- Mix the dry ingredients in water to dissolve the curing ingredients and allow for even distribution throughout the product during regrind.
- If you have the grinding equipment, coarse-grind the meat, add the rest of the other ingredients, and regrind.
- If stuffing sausage, choose only high-quality hog casings that have been salted.
- Soak casings in clean water 30 minutes before use, and rinse them in cold water to remove excess salt.
- Clean grinding and stuffing equipment thoroughly and sanitize surfaces with solution of 1 tablespoon chlorine bleach per gallon of water when done.
- Use properly calibrated thermometers to ensure cooked sausage products have reached proper internal temperature of 160°F (71°C).

Table 11. Recommended Minimum Internal Cooking Temperatures for Game Meats

Types of Game Meat or Bird	*Degrees Fahrenheit*	*Degrees Celcius*
Ground Meat and Meat Mixtures		
Ground Venison, Sausage, Deer Bologna	160	71
Fresh Venison (Chops, Steaks, Roasts)		
Medium	160	71
Medium Rare	145	63
Well Done	170	77
Game Birds/Waterfowl*		
Ground Game Bird Meat	165	74
Game Bird/Waterfowl, Whole	165	74
Duck/Goose	165	74
Wild Turkey, Whole	165	74
Breasts, Roasts	165	74
Thighs, Wings	165	74
Stuffing (cooked alone)	165	74
Stuffing (cooked in bird)	165	74

*Check the internal temperature in the innermost part of the thigh and wing and the thickest part of the breast with a properly calibrated food thermometer.

Cooking with Thermometers

Using a food thermometer is the only reliable method to ensure that your game meat, birds, or fish have reached a proper internal temperature during cooking. For these foods to be safe, internal temperatures must be high enough to kill any harmful microorganisms.

Cook ground meats to 160°F (71°C) and other cuts of game meat such as chops, steaks, and roasts to at least 145°F (63°C) to ensure destruction of foodborne bacteria and parasites. Cook ground game meat, whole game birds, and breast meat to 165°F (74°C). Cooked muscle meats can be pink even when the meat has reached a safe internal temperature. The pink color can be caused by the cooking method, smoking, or added ingredients such as marinades. If fresh game has reached 160°F (71°C) throughout, even though it may still be pink in the center, it should be safe.

It should be noted that color change in a meat product is not always indicative of a proper internal temperature. In some instances, meat may change color (pink to gray or brown) before it reaches a temperature at which pathogens are destroyed. To take the guesswork out of cooking your game, birds, or fish, use a properly calibrated thermometer. On the next page is information about several different types of thermometers that can be

used.

Digital Instant-Read (Thermistor)
Reads in 10 seconds

- Place at least ½ inch deep
- Gives fast reading
- Can measure temperature in thin and thick foods

- Not designed to remain in food while it's cooking
- Check internal temperature of food near the end of cooking time
- Some models can be calibrated; check manufacturer's instructions
- Available in kitchen stores

Fork
Reads in 2–10 seconds

- Place at least ¼ inch deep in thickest part of food
- Can be used in most foods
- Not designed to remain in food while it is cooking
- Sensor in tine of fork must be fully inserted

- Check internal temperature of food near end of cooking time
- Cannot be calibrated
- Convenient for grilling

Dial Instant-Read (Bimetallic-coil)

Reads in 15–20 seconds

- Place 2–2½ inches deep in thickest part of food
- Can be used in roasts, casseroles, and soups
- Temperature is averaged along probe, from tip to 2–3 inches up the stem to the dimple
- Cannot measure thin foods unless inserted sideways

- Not designed to remain in food while it is cooking
- Use to check the internal temperature of a food at the end of cooking time
- Some models can be calibrated; check manufacturer's instructions
- Readily available in stores

Dial Oven-Safe (Bimetallic-coil)
Reads in 1–2 minutes

- Place 2 –2½ inches deep in thickest part of food
- Can be used in roasts, casseroles, and soups
- Not appropriate for thin foods
- Can remain in food while it's cooking
- Heat conduction of metal stem can cause false high reading

Table 12. Nutritive Value of Game Foods

Game	*Preparation*	*Portion*	*Calories (g)*	*Protein (g)*	*Total Fat (g)*	*Saturated Fat (mg)*	*Cholesterol (mg)*	*Iron (mg)*	*Sodium (mg)*	*Zinc*
Antelope	Roasted	3 oz	127	25	2.2	.9	107	3.6	46	1.4
Beefalo	Roasted	3 oz	160	26	5.4	2.3	49	2.6	70	5.4
Buffalo (bison)	Roasted	3 oz	122	24	2.1	.8	70	2.9	48	3.1
Deer	Roasted	3 oz	134	25.7	2.7	1.1	95	3.8	46	2.3
Fowl—flesh only										
Duck										
Domestic	Roasted	1 lb r-t-c*	201	23.5	11.2	4.2	89	2.7	65	2.6
Wild	Raw+	1/2 breast	102	16.5	3.5	1.1	—	3.7	47	.6
Goose	Roasted	1 lb r-t-c*	340	41.4	18.1	6.5	138	4.1	108	—
Pheasant	Raw+	1/2 breast	243	44.4	5.9	1.9	—	1.4	60	1.1
	Raw+	leg, 1 lb, r-t-c*	132	21.9	4.2	1.5	—	1.8	44	1.5
Quail	Raw+	1quail	123	20	4.2	1.2	—	4.2	47	—
Rabbit										
Domestic	Roasted	3 oz	131	19.4	5.4	1.6	55	1.5	31	1.5
Wild	Stewed	3 oz	147	28.1	2.9	.9	104	4.1	38	NA
Squirrel	Roasted	3 oz	116	20.5	3.1	.4	80	4.5	80	NA

NA = No information available
— = Lack of reliable data for a constituent believed to be present in measurable amount.
* r-t-c = ready to cook
+ = Values for cooked not available.
Sources: USDA Handbook no. 8-5, 1979, *Composition of Foods, Poultry Products, Raw, Processed, Prepared,* and USDA Handbook no. 8-17, 1989, *Composition of Foods, Lamb, Veal, and Game Products, Raw, Processed, Prepared, accessed from https://www.ars.usda.gov/ARSUserFiles/80400535/DATA/sr13/sr13_doc.pdf.*

- Some models can be calibrated; check manufacturer's instructions

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Compiled by Catherine N. Cutter, professor and food safety extension specialist.

For more information about food safety, contact Penn State's Department of Food Science at 814-865-5444 or visit the Penn State Extension Food Safety website at **extension.psu.edu/food-safety**.

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