Basics of Sausage Making
Formulation, Processing & Safety

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Contents

Preface

This bulletin is written to provide some of the basic information required to make various types of sausage. It is for those who enjoy good homemade sausage and who wish to obtain the greatest satisfaction from the trimmings and variety meats generated from farm slaughtered livestock or the results of a good hunt.

These recipes are collected from various sources and have been prepared and tested. The author(s) wish to thank the Extension specialists who provided recipes and information for this bulletin.

Sausage making provides a unique way to use the highly edible and nutritious trimmings from beef, pork, lamb, and game meats as well as meats from chicken, turkey, and spent fowl. Historically, sausage is one of the oldest known forms of processed meat and has been a very desirable, "quick-and-easy" meal for generations. The experienced sausage maker uses many meat cuts to produce the characteristics of a particular sausage.

This publication is for people looking for a satisfactory way to use trimmings and other deboned meats. But it's especially for those who enjoy good homemade sausage… the way Grandpa used to make it.

HISTORICAL PERSPECTIVES

Sausage is the oldest form of processed meat products known through historical evidence. It is considered one of the most appetizing, nutritious, enjoyable, and convenient meat products. Homer referenced sausage in the Odyssey as one of the favorite foods of the Greeks. The history of sausage is literally given by its name and many of today's sausages derive their names from the city where they originated, such as Vienna, Frankfurt, Mettwurst, Genoa, Knoblanch, Bologna, Salami, and many others.

Sausages can be made by grinding meat from beef, pork, poultry, or game meat, mixing with salt and other seasonings followed by stuffing into a container or a casing. The word sausage is derived from the Latin word salsus, which means salted or preserved by salting. In the United States, many small and very small meat processors develop excellent sausage products that are particularly popular among local citizens. Such locally processed and produced meat products provide an incentive for meat processors to create sausage products that could use local, cheaper, and more perishable cuts of meat and scrap trimmings. In addition, people from various ethnic groups who immigrated to the U.S. have brought with them traditional recipes and manufacturing skills for creating a wide range of sausage types. Making sausages spiced to meet your own preference is a further incentive to prepare them at home.

Your homemade sausage might even taste better than commercially processed links. Plus you know precisely what is in it!

Today, the sausage manufacturing industry in the U.S. must adhere to government standards for ingredients and processing. In addition, accurate labeling requirements ensure that the consumer is informed of the ingredients in a sausage product. Regulations are more specific for several categories of sausage products, which have specific production processes and storage requirements. These categories include fresh sausages, cooked sausages, and dry cured sausages.

SAUSAGE TYPES

A suitable definition of sausage is ground or chopped meat combined with salt, seasonings, and other ingredients, which can be stuffed into a container or casing of particular shape and size. A wide variety of sausages can be produced by altering the meat source and spices, ingredients, and/or the method of preparation. Over the decades, sausage making and preparation methods have been developed and refined to produce a distinctive style of sausage influenced by the ethnic groups, availability of local ingredients, spices, and casings. Many cultures around the globe have attempted to create their own ethnic style of making sausage. Native Americans made their own sausages with a variety of meats and berries, called pemmican.

Classifying sausages into a specific category is difficult because sausages are produced by many different methods. The following is a simple and broad classification of the various sausage types, based upon processing procedures and product characteristics.

Fresh Sausage is made from coarse or finely ground meat. It is mixed with seasonings and can be stuffed into casings, wrapped as a bulk package, or pressed into patty form. This type must be refrigerated and thoroughly cooked before eating.

Fresh sausage is typically prepared from one or more kinds of meats, but not from meat by-products (heart, kidney, or liver, for example). It may contain water (not exceeding 3 percent of the total ingredients in the product) and binders and extenders (for example, wheat flour and non-fat dry milk). Examples include fresh pork breakfast sausage, Italian sausage, bulk pork sausage, and most bratwurst.

Use a hamburger patty maker to make consistently sized sausage patties. They won't take up much room in your freezer, and they can be thawed and cooked quickly.

Content of Fresh Sausages

According to USDA's product definitions:

- **Fresh Pork Sausage** may not contain pork by-products and may contain no more than 50 percent fat by weight.
- **Fresh Beef Sausage** may not contain beef by-products and may contain no more than 30 percent fat by weight.
- **Breakfast Sausage** may contain meat and meat by-products and no more than 50 percent fat by weight.
- **Whole Hog Sausage** contains the approximate amount of meat that would come from one hog and no more than 50 percent fat by weight.

- **Italian Sausage** products are cured or uncured sausages containing at least 85 percent meat, or a combination of meat and fat, with the total fat content not more than 35 percent of the finished product. It may contain salt, pepper, fennel, and/or anise and no more than 3 percent water. Other optional ingredients permitted in Italian Sausage are spices (such as paprika) and flavorings, red or green peppers, onions, garlic, parsley, sugar, dextrose, and corn syrup.

Cooked and Smoked Sausages

Cooked and Smoked Sausages are made from meats that are ground, seasoned, stuffed into casings, and fully cooked (to a minimum internal temperature of 155° F) and smoked during processing. Cooked sausages, like frankfurters or bologna, are made from fresh or frozen meats that are cured during processing, fully cooked and/or smoked, then packaged as ready-to-eat products.

Smoking your sausage gives it a whole new flavor.

Cooked sausages constitute a majority of all sausages produced in the United States. Generally, cooked sausages are perishable and will last approximately seven to 14 days under refrigerated conditions. These sausages must be refrigerated all the time, up until time of consumption. Since most processors prefer to vacuum package these sausages, consumers should pay attention for storage-life and re-heating conditions. Typically, cooked and smoked sausages develop some additional flavors through the addition of nitrates and during the cooking and smoking processes. Examples of cooked and smoked sausages are wieners, bologna, Berliner, cotto-salami, frankfurters, and red hots.

Frankfurters, bologna, knockwurst, and Vienna sausages are made from finely ground, emulsified meats. These types of sausage are permitted by regulations to contain up to 40 percent of a combination of fat and added water, with no more than 30 percent fat in the finished product. Polish sausage, cotto-salami, and smoked sausage are more coarsely ground, but USDA regulations have no restrictions on fat limitations. Total water content, however, is limited to a maximum of 10 percent of the finished product weight.

Other types of cooked sausage, such as braunschweiger, liver sausage, and blood sausages, are either steam-cooked or cooked in a water bath. Typically, these sausages are stuffed in an impervious casing or steel mold before the cooking process. The impervious casing allows the sausage to retain moisture during cooking. Processors however, are required to monitor and control the amount of added water during formulation to ensure that it does not exceed the 10 percent limit. In addition to the standard production steps used to make fresh sausages, cooked and smoked sausages have more production stages, including:

Polska kielbasa (Polish sausage) makes a hearty meal.

- Smoking
- Cooking
- Showering
- Chilling
- Peeling

Cooked and smoked sausages are typically composed of a wide variety of meat and non-meat ingredients and each ingredient contributes specific sensory and textural properties to the final sausage formulation.

Uncooked, Smoked Sausages are manufactured from ground meat, seasoned, stuffed in casings, and smoked. These sausages are smoked for flavor development; they MUST be fully cooked before eating. Uncooked, smoked sausages must be stored under refrigerated conditions or can be frozen for longer storage.

The USDA Food Safety and Inspection Service (FSIS) requires "safe handling instruction" labeling for uncooked, smoked sausages that are NOT ready to eat. In cases where the sausage is partially cooked or otherwise appears cooked but requires cooking by the consumer for safety, USDA FSIS requires additional labeling features, such as a prominent statement on the principal display panel (for example, "Uncooked", "Ready-to-cook", "Cook-before-eating", "Cook and serve," or "Needs to be fully-cooked"). In addition, the product should display cooking directions that are sufficient for the intended user to prepare it properly. The manufacturer must validate that the cooking directions are sufficient to destroy any pathogens that could be present. If a sausage is perishable, the label must say "Keep Refrigerated." Some examples are kielbasas, mettwurst, teawurst, and smoked country style pork sausages.

Dry or Fermented Sausages are prepared using ground meats, which are seasoned, cured, stuffed in casings, fermented, often smoked, and carefully air-dried. Dry and fermented sausages develop a characteristic tangy flavor due to fermentation and the production of lactic acid. The lactic acid is produced by microbial fermentation of the sugars, and the addition of salt often provides a distinctive and enticing aroma, flavor, and a characteristic "bite." Sausages are dried for varying lengths of time during processing and smoking, depending on the sausage type.

Fermentation and drying are the oldest way of preserving meat and meat products. The drying is accomplished by adding salt to meat to prevent spoilage. They are also referred to as "summer sausages" and eaten cold. Some examples are summer sausage, Italian salami, German salami, Lebanon bologna, Genoa salami, thuringer, cervelat, and pepperoni.

Fermented Sausages are prepared from chopped or ground meat products that, as a result of microbial fermentation of a sugar, reach to a pH range of 4.6–5.3 (pH of 4.6–5.0 is more typical) and have undergone a drying or aging process to remove 15–25 percent of the moisture. These products are typically cured, but not necessarily cooked or smoked. Dry- and semi-dry sausages are considered shelf stable due to low water activity (aw), and may be sold and consumed without further cooking or heat treatment. Sausage products must have an aw below 0.85 and a pH under 5.3 to be shelf stable. Examples are pepperoni and salami(s).

Semi-Dry Sausages differ greatly from dry sausages due to their pronounced tangy flavor. These products are generally stuffed in medium- to large-diameter natural casings, and the length of fermentation, drying, and/or smoking depends on their type. The final pH of semi-dry sausages varies from 4.7 to 5.4, but their moisture content is typically 35 percent or higher. Semi-dry sausages may be smoked and slightly cooked in the smokehouse and after smoking, or these sausages may be air dried for a relatively short time.

Compared with dry sausages, semi-dry products have higher water activity (aw) values (greater than 0.90 up to 0.91). The main difference with semi-dry fermented sausages is the long ripening and drying process, during which biochemical and physical changes occur that strongly influence their stability and safety. Due to the aw, which ranges from 0.85 to 0.91, dry fermented sausages exhibit high shelf stability as compared to semi-dry and can be kept without refrigeration.

Mold-Ripened Sausages are raw, fermented products usually with a longer ripening and drying time. Mold-ripened sausages can be classified as very similar to fermented sausages. Mold growth requires time and a supporting environment with adequate temperature and relative humidity. The starter culture can be the mold present either as native flora or added as an artificial inoculum. Mold growth and changes in ripening conditions are the basic differences between sausages with and without mold. These sausages can be made traditionally with added starter culture in and on the sausage; semi-traditionally with no added bacterial or mold starter culture; or with the addition of bacterial and mold starter culture simultaneously. Adding bacterial starter culture such as staphylococci and/or lactobacilli and yeasts contribute to the development of typical aroma and flavor with a reduction of ripening and drying time. The pre-requisite criteria for high quality fermented sausages are: Starting with high quality raw materials, using a clean and hygienic processing environment, and implementing a well-controlled process.

SAUSAGE INGREDIENTS

Meat Sausage making is a great way to use less tender, low-value cuts and trim pieces. Good sausage begins with good meat. Beef, veal, pork, lamb, mutton, and poultry are all suitable for use in sausage. A majority of sausage products are prepared with pork and beef. Often game meats can be used to make sausage. If you slaughter your own animals, meat from the head, trimmings, and the thin cuts can be saved for sausage. Meat from the neck and back of poultry and meat from the entire carcass of spent fowl can also be used.

IT IS CRITICAL THAT THE MEAT IS HANDLED PROPERLY AFTER THE ANIMAL IS SLAUGHTERED AND KEPT COLD—BELOW 40º F.

Proper dressing and rapid refrigeration will limit bacterial growth and reduce the chance of getting a foodborne illness. If you plan to purchase meat for your sausages, inexpensive cuts such as beef plates, chuck cuts, and pork jowls and shoulders can be used. Always use fresh, clean meat ingredients.

Venison and other game may be substituted for all or part of the lean meats in the recipes in this booklet. Because wild game is slaughtered under less than desirable conditions, it is important to properly trim this type of meat. Game meat should be processed in the same manner as pork or beef, except for the fat. All external fat should be removed prior to grinding. The majority of "gamey" flavor comes from fat, not the lean. You can add pork or pork fat into the game meat during grinding and processing in order to achieve a desired texture and flavor.

Word of caution: Always be sure to remove any meat that is slimy, has an off-odor, or is dirty.

Variety Meats or fancy meats may also be used in sausage manufacture. It provides the sausage maker with an opportunity to use various types of meat by-products, also known as "variety meats," such as hearts, tongues, livers, tripe, blood or blood plasma, brains, lungs, udders (non-lactating), spleens, suet and cod and brisket fat, pork stomachs, gelatinous skins, pork back-fat and caul-fat, ears, snouts, ox lips, etc. The specific amount and type of variety meats used in a sausage product will depend on the processor's formulation. USDA regulations allow use of variety meats to be used only in cooked sausages, like hot dogs, as long as the name of the product is modified to include the words "with by-products" or "with variety meats" and the particular types of variety meats are included in the ingredients list in the order of predominance in the formulation.

Tongues, after removal from the head, are washed, chilled, and trimmed.

After the livers have been removed from the carcass and veterinary inspected, the gall bladder is cut off. Care should be exercised not to puncture the bladder because the gall fluid inside can spoil the liver. The livers are washed with a minimal amount of water. They are kept in a chiller or freezer if not used immediately. Calf and pig livers particularly are used for the manufacture of liver sausages.

Hearts are cut open, washed, and chilled or frozen. Kidneys are skinned, trimmed of fat, and chilled or frozen.

In obtaining tripe (stomach of cattle, sheep, or goats), the first and second rumens are cleaned, carefully washed, hand-scrubbed with brushes, and their mucous linings are removed. They are then trimmed of adhering tissues, cooked, trimmed free of fat, and used in sausage manufacture or kept in a chiller or freezer for future use. Pork stomachs are cut open, emptied, and washed; the mucous coating is then removed and the stomachs are cooked, chilled, and then used in sausages.

Game Meats Venison and other game meat may be substituted in sausage recipes to create a unique and original flavor. Because game meat is often slaughtered under less sanitary conditions, it is very important that the meat is handled properly after the animal is killed and to retain the wholesomeness and condition of the meat. It is good practice that any evidence of spoilage (discoloration, off-odors, stickiness, slime, etc.) should be carefully trimmed from the carcass and discarded. The animal should be bled and dressed as soon as possible after killing and the meat MUST be kept cold (below 40° F) at all times.

Game meat is generally processed the same way as pork or beef, except for the fat. All external fat should be removed prior to grinding. The majority of "gamey" flavor comes from fat, yet a sausage without any fat will turn dry and unpalatable. Thus, pork/pork fat (not salted pork fat) is often added with game meat when grinding. It is common to use a pork shoulder butt as a source of fat for game sausages. The sausage should have 15 to 20 percent fat content to achieve a desirable texture and flavor.

Different blends of meats and fat percentages will affect the final product, but caution should be exercised to find what taste and flavor fits you the best. Sausage made from game meat offers an interesting and unique experience for home sausage makers.

Salt is an essential ingredient for flavor and functionality in sausage. It aids in the water binding and emulsifying capacity of meat proteins. Use of salt alone provides a dry salty product, which gives the sausage a bitter taste of salt and an unattractive color. Salt should be pure and sufficiently finely granulated so it can dissolve easily in the meat. Salt is necessary for enhancing flavor, preserving the sausage from microbial spoilage, and extracting the soluble meat proteins. The extracted meat protein forms a film and coagulates during heating and binds the meat particles together providing a firmer texture for sausage.

Most sausages contain 2–3 percent salt. Salt levels can be adjusted to your taste. There are also many different varieties of salt available for consumer purchase:

- **Rock salt** is generally produced from dried, underground seabeds;
- **Table salt** is refined and fortified with iodine and contains anti-caking compounds to prevent clumping or caking;
- **Kosher salt** is an unfortified rock salt without anti-caking ingredients that can be used when cooking, but will need roughly 1/3 more when replacing table salt in recipes; and
- **Sea salt** is obtained from evaporated seawater.

Sugar is used for flavor development and to counteract the slight, bitter taste of salt. A variety of sugar sources can be used to provide sweetness and flavor to sausage. These include sucrose (table sugar), brown sugar, dextrose, and corn and maple syrup. Sugar is also used as a substrate for microbial fermentation to reduce the pH of the dry and fermented sausage. The lactic acid produced due to fermentation reduces the pH of the meat and gives sausage a characteristic tangy flavor.

Spices are found many forms: fresh, dried, whole, crushed, pureed, as paste, and as an extract. The commercial meat processing plants use spice extracts in place of natural spices. Seasonings and spices used for sausage making should be fresh. Most consumers prefer the taste of freshly made food that often comes from spices. However, spices are also known to be a source of microbial contamination. For the best outcome, buy the best spices with the greatest purity. Most spices lose their natural flavor when held for six months or more at room temperature. For the best results, store seasonings and spices at 55º F (13° C) or below in airtight containers. Remember, the characteristic flavor of a sausage comes from the spices, herbs, and flavorings that are used, so buy the best quality seasoning that you can get.

Commercial premixed seasonings are available for most sausage types. Ask your butcher, check with your local meat processor or butcher supply house, or look online. For making small batches of sausage at home, premixed blends are excellent for providing good spice combinations.

Nitrates and Nitrites The use of nitrite to preserve and cure meats evolved centuries ago. It is one of the oldest forms of food preservation. It has great benefit for the production of sausage with improved food safety with extended shelf life and excellent storage stability. Many of today's cured sausage products enjoyed by consumers contain sodium nitrite. Curing imparts unique colors, texture, and flavors that cannot be recreated by any other ingredient. These curing ingredients are required to achieve the characteristic flavor, color, and stability of cured meat.

Nitrate and nitrite are converted to nitric oxide by microorganisms and combine with the meat pigment (myoglobin) to give the characteristic pink cured-meat color. However, more importantly, nitrite provides protection against the growth of botulism-producing microorganisms, acts to retard rancidity, and stabilizes the flavor of cured meat.

Extreme caution must be exercised in adding nitrate or nitrite to meat, since too much of either of these ingredients can be toxic to humans. In using these materials, never use more than is called for in the recipe. A little is enough. Federal regulations permit a maximum of 2.75 ounces of sodium nitrate or potassium nitrate per 100 pounds of chopped meat and 0.25 ounces of sodium nitrite or potassium nitrite per 100 pounds of chopped meat. Potassium nitrate (saltpeter) is the salt that has been used historically for curing meat. However, sodium nitrite alone, or in combination with nitrate, has largely replaced the straight nitrate cure.

Since these small quantities are difficult to weigh on most available scales, it is strongly recommended that a commercial premixed cure be used when nitrate or nitrite is called for in the recipe. The premixes have been diluted with salt so that the small quantities that must be added can more easily be weighed. This reduces the possibility of serious error in handling pure nitrate or nitrite. Several premixes are available. Many grocery stores stock Morton's Tender Quick Salt and other brands of premix cure, or look online for sausage premix cure. Use this premix instead of the amount of salt in the recipe; it will also supply the needed amount of nitrite simply and safely.

The use of sodium nitrite for curing has not been without controversy. However, this has been settled and all sausage products produced using nitrite have been shown to be free of known carcinogens. New research conducted since the mid-1980s has suggested that nitrite is a significant molecule important for human health. Dietary nitrates from vegetables (celery, cabbage, broccoli, etc.) have been shown as source for the natural production of nitrite and nitric oxide in the human body.

Remember, meats processed without nitrite are more susceptible to bacterial spoilage and flavor changes, and probably should be frozen until used.

Starter Culture is an inoculum of bacteria that produce lactic acid from sugar. Sausage processors can use a starter culture for making a batter for summer sausage, snack sticks, etc., prior to filling and stuffing. In order to get successful fermentation and lactic acid production, the stuffed sausages must be held at temperatures favorable for bacteria growth (80–100° F) for 10 to 15 hours minimum to allow the starter culture bacteria to grow and ferment the sugar to lactic acid. A noticeable aroma is usually present during this fermentation period indicating that fermentation is indeed occurring. Without an effective starter culture in the batter to rapidly produce acid, these abusive fermentation temperatures can pose a microbiological safety risk by allowing dangerous bacteria to grow in the meat product.

Historically, some processors have relied upon chance inoculation by bacteria in the environment or that are normally present in meat. However, if naturally occurring lactic acid bacteria are not present at sufficient amounts, the characteristic "tangy" flavor may not develop adequately in the sausage. Appropriate caution should be exercised to make sure starter culture is added in sufficient quantity to develop the characteristic tangy flavor and pH drop. Many suppliers offer a frozen or freeze-dried starter culture that can be used as starter culture bacteria. Although most starter cultures will ferment common table sugar (sucrose), most sausage makers choose to include in their fermented sausage recipe bacteria that ferment the simple sugar dextrose.

Encapsulated Acids Many meat processors have started to use encapsulated citric or lactic acid to the batter for the acidification of their sausage. Encapsulated acids are small beads of acids enclosed in a lipid coat. These acids are gently blended into the batter near the end of final mixing—do not grind the meat after mixing and don't damage the lipid coat. The sausage can be cooked immediately. When the batter temperature reaches 137° F, the lipid coat melts, releasing the acid.

Direct addition of acid must be done in this encapsulated form because direct addition of unprotected acid to the batter during mixing would cause the meat proteins to coagulate while still in the mixer, ruining the product texture. Encapsulated acids are the easiest way for home meat processors to get a tangy flavor into their summer sausage. If used correctly, it is almost impossible to tell if the sausage was manufactured by fermentation or by the use of the encapsulated acid.

Encapsulated acids are a simple way for the meat processors to give a tangy flavor to their sausages. Care must be exercised while using the encapsulated acids. Mixing for too long or cooking at too low

of temperature can cause off flavor and color development, which is highly undesirable.

Reducing Agents Ascorbates and erythorbates are chemicals used interchangeably in cured sausages to which nitrite has been added. They are active reducing agents that react with nitrite to accelerate the curing process. Examples of reducing agent ingredients are given in Table 1. Sodium erythorbate is chemically similar to ascorbate, and both can be used as "cure accelerators" as an optional ingredient. Note that many recipes call for holding the meat overnight to cure. This is required to allow the bacteria to convert the nitrite to nitric oxide. The addition of ascorbic acid (Vitamin C) or sodium erythrobate speeds the curing reaction and eliminates the holding time. USDA regulations allow the use of up to 7/8 ounce per 100 pounds of meat.

Antioxidants Antioxidants are approved for use in fresh sausages to retard oxidative rancidity and protect flavor, including butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), propyl gallate, tertiary butylhydroquinone (TBHQ), and tocopherols. These compounds are added to spice mixtures based on the actual percentage of fat in the fresh product formulations (typically 0.01 percent separately, 0.02 percent in combination) or on the total meat block weight for dry sausage formulations (typically 0.003 percent).

Ingredients	Maximum Amount
Ascorbic acid	3/4 oz. per 100 pounds of meat
Erythorbic acid	3/4 oz. per 100 pounds of meat
Sodium erythorbate	7/8 oz. per 100 pounds of meat
Citric acid	May replace up to 50 percent of above listed ingredients
Sodium Citrate	May replace up to 50 percent of above listed ingredients
Sodium acid pyrophosphate	Alone or in combination; may not exceed 8 oz. (0.5 percent)
Glucono delta lactone	8 oz. per 100 pounds of meat

Table 1. Reducing Agents for Curing Sausages

Mold Inhibitors Mold is a commonly encountered problem in the production of dry sausages. The common technique for preventing the growth of mold is to dip the sausage in a mold inhibitor solution, typically 2.5 percent solution of potassium sorbate or a 3.5 percent solution of propylparaben.

Binders and Extenders Sausages may contain other ingredients such as binders and/or extenders to retain natural juices and reduce the cost of the formulation. These ingredients help may improve the binding characteristics, flavor, cook yield, slicing characteristics, and reduce the cost of the sausage formulation (i.e., extenders). The most commonly used ingredients of this type are non-fat dry milk, cereal flours, and soy protein products. You may use these ingredients in most sausage products, depending on your taste. If you use soy, wheat, egg, or milk products in your formulation, be sure you declare them in the allergen statement on your label.

Water is added to most sausage formulations to rehydrate the nonfat dry milk and to replace the expected moisture loss during smoking and cooking. Approximately 10 percent added water typically is used in moist types of cooked sausage. A small amount of water (usually less than 3 percent) is added to fresh sausage to aid in stuffing, mixing, and processing. No water is added to sausages that will be dried, such as summer sausage or pepperoni.

Casings sausages may be formed into loaves and oven baked. However, most sausages are either wrapped or packaged in bulk chub packs or stuffed into casings. Two types of sausage casings are natural and synthetic. Natural casings are obtained from the digestive tract of animals. These casings are made from sheep (3/4-inch in diameter), hog (1-3/8 inches) and cattle (1-3/8 inches) intestines. These usually come in lengths of several feet packed in salt in one pound cups or in bulk by the yard. Although they may cost 12 to 15 cents per pound of stuffed sausage, they offer the advantage of being edible. One hank or small container of pork casings will stuff 40 to 50 pounds of sausage. Natural casing wieners and some breakfast sausages are stuffed in lamb casings. Ring bolognas are typically stuffed in beef casings. Natural casings always have a natural "curve" to them and a very desirable "snap" when you bite into the sausage.

Fresh bratwurst. (Photo courtesy of Bobak Sausage Co.)

Edible synthetic casings made from collagen are also available, in approximately the same sizes as the natural casings. Collagen casings are derived from animal protein, often extracted from beef hides, and manufactured into an edible casing (collagen is also the main protein present in natural casings). Collagen casings are used on some breakfast links, bratwurst (especially pre-cooked bratwurst), and other types of linked sausages. Collagen casings provide straight sausage links (no curve).

Synthetic casings come in a variety of forms. "Skinless" hot dogs are manufactured in cellulose casings (made from inedible plant and tree fibers), which allow smoke to penetrate and moisture to escape during cooking. Large synthetic casings, which are used for slicing products such as summer sausage or bologna, are not edible. These cellulose or fibrous casings have the advantage of being uniform in size (diameter) and generally free of defects. They are available from most butcher supply houses or online in sizes from 3/4-inch to 6 inches in diameter. After skinless franks are cooked and cooled, the cellulose casings are peeled off and discarded, producing "skinless" products. Larger size cellulose casings have paper fibers added for strength, and are termed "fibrous" casings. They are used for summer sausage and larger diameter slicing products.

Sausage links can make any breakfast special.

Be sure to select the proper size casing for the sausage being made. Small edible natural casings from sheep or hogs are typically used for fresh sausage, while the larger beef casings are used for cooked and smoked sausages. Recommended casing size and type will be given for each sausage recipe in this publication. They may be available in some grocery stores, butcher shops, meat packing plants, butcher supply houses, and online.

Use the following steps to prepare casings for use:

1. **Remove the amount of casings needed from the storage container and cut into 3 to 6 foot lengths for easier handling.**
2. **Remove the salt by rinsing casings in running water and then soak for one to two hours prior to use. This allows time for the casings to become soft and workable.**
3. **Before stuffing, insert two fingers into one end of the casing to open and separate it, then hold under the faucet and let water run through the entire length.**
4. **Pack sausage as directed in the recipe.**
5. **Rinse any leftover casings in cold water and thoroughly drain. Then re-pack the casings in a layer of salt in the original container. These will remain usable for about one year.**

SAUSAGE MAKING EQUIPMENT

The primary consideration in choosing your sausage making equipment is the amount of sausage you plan to produce. Are you going to make just enough for your family? Or are you planning to go into business and make it to sell in the marketplace?

The three most important pieces of equipment, regardless of the amount of sausage you plan to make, are an accurate thermometer, a calibrated scale, and a meat grinder. Smoked or smoke/cooked sausages require a smoker (small batches) or a commercial smokehouse, such as one made by Alkar or Koch. Emulsion-type cooked sausages, such as frankfurters or bologna, use a bowl chopper to make finely ground meat batter that is put into casings and cooked or smoked.

Thermometer

An accurate thermometer is necessary for ensuring that raw meat does not get warmer than 40° F during processing. It is also needed to measure the internal temperature of cooked sausages, which must be hot enough to kill any possible pathogens in the product. Most sausages are considered fully cooked when they reach an internal temperature of 160° F.

Scale

A scale that can be calibrated in either ounces or grams before each use will make the task of weighing the meat and other ingredients of your desired recipe much easier. Keep a record of what you like and don't like about each recipe, so that you can produce a consistent product.

Meat Grinder

Both old-fashioned, hand-cranked (manual) and electric meat grinders are readily available in kitchen or restaurant supply stores or online. Based on your needs, be sure that you also get the appropriate grinding plates and knives, "meat stompers" (to push chunks of meat into the grinding gear), and other implements to fit your selected grinder. The grinder consists of a screw auger, a

four- or five-bladed knife, and plates with numerous holes to produce the desired texture of the sausage. A coarse grind is made with a plate with 1/4-, 3/8- or 1/2-inch holes; the fine grind is produced by 1/8 or 3/16-inch holes. It is important to keep the knife blades sharp because dull equipment produces excessive heat and makes a smeared product.

An old-fashioned hand grinder can turn out well-ground meat for your sausage.

A bowl chopper is used to make a finely ground, emulsified sausage batter, as for bologna or hotdogs.

After the first grinding of the meat and all of the spices have been mixed in, a stuffing horn may be attached to the grinder for the second grind to fill sausage casings. Watch for air pockets in the meat as it fills the casings—these can be removed by piercing the casing with a sterile needle.

Bowl Chopper A bowl chopper cuts meat with high-speed rotating blades and a bowl that also rotates. It is used to produce finely ground, emulsified batter for sausages like bologna or hotdogs. It can also be used instead of a grinder at slower speeds, although the cost of a bowl chopper may be outside the price range for most small processors.

The chopper warms the emulsified batter through friction to allow meat proteins to encapsulate microscopic fat particles. Temperature control is very important during this operation so that the optimum end temperature of the batter is approximately 63° F.

Sausage Stuffer An electric piston sausage stuffer will fill casings much more quickly than a hand-operated, screw-type, and with fewer air pockets. A stuffer is not essential to making sausage at home; you can form the meat into patties or wrap as bulk packages. Links in casings can be tied off with heavy string or by twisting the sausage at certain intervals.

SAUSAGE MAKING PROCEDURES

The most critical step in sausage making is to be sure your equipment and work area are clean and sanitized before you start.

The basic steps in sausage making are:

- Weighing/measuring the ingredients
- Grinding
- Stuffing/linking
- Smoking/cooking

Weighing and Measuring

Weighing or measuring the meat and spice ingredients is one of the most important steps in the preparation of a good sausage. Always calibrate your scale before using it to weigh out the proper amounts of lean meat, fat meat, and each individual spice or added ingredient, to be sure that the formulation is correct. There is nothing more disappointing than to make sausage that is too hot or spicy or not properly seasoned. If it is not possible to weigh the ingredients, be sure to measure them properly. Remember, weights are always more accurate than measures.

Mixing

Mixing the meat and other ingredients is a simple but important step. Before the spices and dry materials are added to the meat, cut the meat into 1-to 2-inch squares. Spread the meat in the bottom of a large pan. Sprinkle the spices and dry ingredients over the meat and mix thoroughly. Add water, ice, or wet ingredients last and mix again. This mixing will ensure a uniform distribution of spices and develop the binding ability of the meat. If nitrate or nitrite is to be used in the formula, dissolve it in a small amount of water before adding. This will ensure a uniform distribution throughout the sausage.

Grinding

Small manual or power grinders are available from most hardware or appliance stores or online. These are adequate for home sausage making. Larger models are available from restaurant or institutional suppliers and online.

The key to doing a good job grinding is to use sharp blades and plates that match. Clean out any gristle and bone fragments from the meat so that the plate and blade will fit together. Avoid smearing or crushing the meat through the plate. This will change the texture and color of the sausage, making it mushy. The sausage may be ground twice, especially if two meats, such as a fat meat and a lean meat, are being used. Grind each meat through a 3/8-inch coarse plate. Add the spices and other ingredients, mix, and then grind again through the final 1/8- or 3/16-inch plate. If two plates are not available, the spices can be added to the meat pieces, and then you can grind it twice through the small plate. A single grind is usually not adequate.

Stuffing and Linking

Getting the sausage into the casings may present a problem if you do not have a stuffer. The simplest stuffer is a horn, which fits on the grinder. Be sure to select the appropriate size of tube for the casing you will be using. One drawback of using a stuffing horn on a grinder is that too much air remains in the ground meat—a sausage-making no-no.

However, a separate sausage stuffer can be used to put the mixed ground meat directly into the casing with minimal air pockets and less risk of pathogenic bacteria. Follow the manufacturer's instructions for cleaning and assembling the stuffer.

Prepare the casings as directed by the manufacturer. (See "casings" in the previous section on sausage ingredients.) Keep the casings wet until ready to fill. Lightly grease the stuffing horn with vegetable oil or lard, and then slip the open end of the wet casing carefully onto the horn. Slide the casing carefully onto the tube to prevent tearing until the entire casing is bunched on the stuffing horn. Be sure the horn and casings are wet. This will allow the casing to feed freely off the horn as it is filled.

Put some meat through the stuffing horn until it is filled and the sausage mixture starts to peek out. Pull 1 or 2 inches of wet casing out over the end of the horn. Knot the casing as close to the horn as possible to prevent air pockets from forming in the casing. Air pockets may also be prevented by packing the sausage tightly into the stuffer. Or you can pierce the filled casing with a sterilized needle in several places to allow any trapped air pockets to escape.

Hold the casing at the mouth of the horn with the thumb and forefinger, and allow it to slide off under your fingers as the sausage is pumped in. If the casing is held too tightly, the pressure of the meat will tear the casing. Allow as few air pockets as possible to form in the casing. Stop stuffing about 2 inches from the end of the casing so that the casing can be knotted or tied off. If the sausage is to be made into links, the casing must be stuffed loosely so that the casing will not burst when twisted several turns to form the link. Links may also be formed by tying the casing with cotton string after stuffing.

Large casings (2- to 6-inches in diameter) are stuffed in the same manner as the small casings, using a larger stuffing horn. These casing should be pre-tied at one end with the open end fed completely over the horn. Grip the casing firmly with the thumb and forefinger on the mouth of the horn and allow it to feed out as it fills. Do not let your fingers slip over the end of the horn. Leave about 2 inches of casing empty to tie off with string or a knot. Air pockets may be removed by pricking the casing with a sterilized needle. Tie the casing string tightly and leave enough string to hang the sausage in the smokehouse.

Smoking and Cooking

Smoking, drying, and salting of meat and meat products are one of the oldest methods of food preservation. Smoking has been traditionally used for shelf life extension and development of the typical sensory flavor associated with smoked meats. Sausages and other meat products are smoked for flavor and color development and to preserve the product.

In traditional smoking, a smoke generator or small fire creates natural smoke through a controlled burning of hardwood sawdust, wood chips, or logs. Hickory is the most popular wood used for smoking, but other hardwoods and fruitwoods may also be used. Coniferous trees such as pine are unacceptable because they contain resins. Smoke from that type of wood has a high tar content and imparts a bitter flavor. The temperature of the smoke also affects the sensory properties and the preservative effect and controls the rate of the process.

Cook all meat products to the recommended internal temperature (160°F for ground beef or pork sausage and to 165°F for ground chicken or turkey sausage) to ensure food safety.

Sausage makers MUST control the moisture level of the sausage before and during the smoking process. This is required to produce a high quality product. The surface of the sausage must be slightly moist for the smoke to properly penetrate the casing. If the product surface is too moist, the smoke process will cause streaking. If the casing is too dry, the smoke will not properly adhere to and permeate the casing. Sausage makers are therefore cautioned to ensure that the drying cycles are carefully controlled to ensure a consistently smoked product.

In the last few decades, the process of meat smoking has progressed tremendously for different purposes. During traditional smoking, the composition of the smoke can be controlled by optimizing the smoke process to ensure the required sensory properties and safety of the smoked products are met. However, these products are not completely preserved unless the product is partially dried, as was done before refrigeration was available. In non-traditional smoking, various new liquid smoke preparations are available for home or commercial sausage manufacture. Sausages may be smoked in the raw state or after previous salting, marinating, cooking, or other treatment, which may also be followed by other processing.

Hot smoking is used when the product is to be partially or completely cooked. In hot smoking, the first stage (approximately 30 minutes, without smoke, at 105–125° F) results in the pre-drying of the surface and is followed by several stages of smoking in dense, hot smoke (at temperatures reaching 185° F) and further surface drying. Hot smoking is a more flavorful cooking process—the smoke is added to the product during the cooking cycle. The rate the smoke is deposited on the meat product is affected by the relative humidity and the temperature. As the smokehouse temperature increases, the more rapidly the color will develop on the surface. Higher relative humidity permits greater penetration of the smoke flavor through the casing, but the color does not develop as rapidly. If the relative humidity gets too high, creating hot steam in the smokehouse, the natural casings will break down and the sausages will fall on the smokehouse floor. A relative humidity of 35 to 45 percent is best for most products. The home sausage maker will have to experiment with the equipment to determine which procedure produces the most desirable product.

Cold smoking is used in manufacturing raw, fermented sausages made from cured meats. Cold smoking is basically a drying process that adds the smoke color and flavor to the product. Cold smoking takes place in the range of 53.6–77° F and warm smoking at 73.4–113° F. The smoke, at 53.6–77° F and controlled humidity, is applied for several hours up to about 16 days, depending on the assortment. The loss of water due to drying and the impregnation of smoke components should be equal on the whole cross section of the product. The surface of the freshly cut sausage should be light brown to dark brown, depending on the duration of the process. Dry sausages such as salami and pepperoni are cold smoked. Other products like cured bacon and fresh sausage may be cold smoked for added flavor.

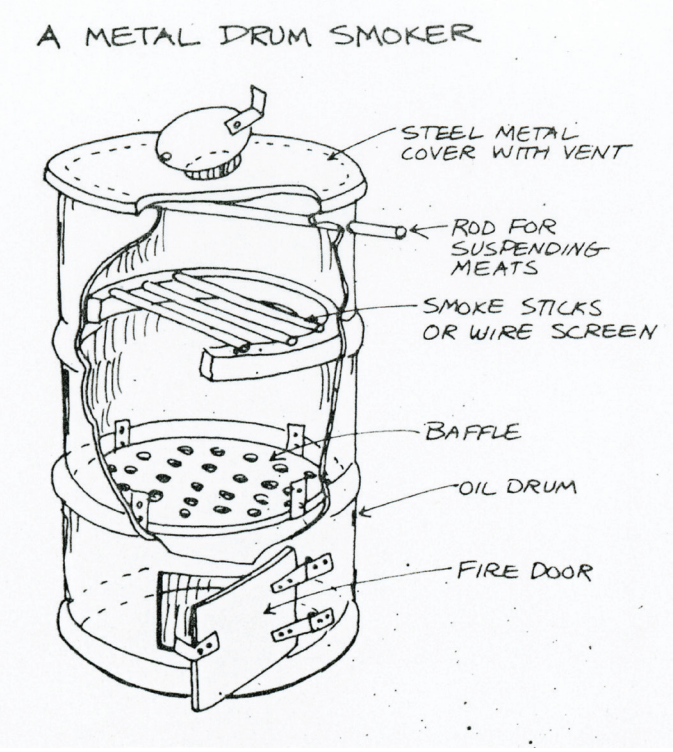
Liquid smoke may be used in the sausage formula if a smoke flavor is desired and no smoking equipment is available. Use about a half-teaspoon of liquid smoke to one pound of sausage. Dilute this in the water added to the meat before mixing to get good distribution.

Smokehouse schedules will be given in the various sausage formulas presented in this bulletin as guides. A substitute method of cooking some sausages is to gently cook them in a water bath at 160º F to 175º F until the internal temperature reaches 160º F. Sausage may also be placed into loaf pans (like meatloaf) and cooked in the oven at 200º F. Cook until the temperature in the center of the sausage loaf is 160º F, and then chill or freeze the sausage if it is not to be eaten immediately.

Smokehouses Several commercial smokehouses are available for larger processors. Kettle-type barbecue grills or smokers, or a small backyard smoker that can easily be constructed, will serve the purpose for home use.

Electric portable smokers are available from most sporting goods and hardware stores. These units consist of a metal box with an electric heating unit, a pan for sawdust or chips, and a recipe booklet. Most are large enough to smoke about 20 pounds of poultry or meat.

Metal drums or wooden crates can provide the skeleton for building a home smoker. The functional parts of a smoker are: 1) a smoke and heat source in the bottom, 2) a baffle to distribute the smoke, 3) a pan of water for humidity, and 4) a screen or racks on which to place the meat or hang the sausages. Vents are needed at the top and bottom for draft control to regulate the temperature and smoke.



A smoker made from a metal 55-gallon drum.
(Originally published in UGA Extension Bulletin 865, "Sausage and Smoked Meats.")

An electric hot plate, charcoal, or hot coals may also be used as heat sources for a homemade smoker. Damp sawdust or wood chips can be placed in a pan on the hot plate as the smoke source. When using charcoal or hot wood coals, sprinkle damp sawdust or wood chips over the burning briquettes to produce the smoke.

Barbecue grills with a lid and vents or kettle types may also be used as smokers. Keep the bed of coals to one side of the grill so that the meat is not cooked and regulate the smoke by adjusting the vents. Produce smoke as above.

IMPORTANT CONSIDERATIONS IN SAUSAGE MAKING

Temperature Meat products are extremely perishable and must be maintained under refrigeration (40º F or below). The temperature of drying, smoking, and cooking must be continuously and carefully monitored and controlled to ensure a consistent product. Processing temperatures and times must be sufficient to eliminate any pathogens of concern. A calibrated (traced to the National Institute of Standards and Technology [NIST] standard) thermometer is necessary to ensuring that raw meat and meat ingredients do not exceed 40° F while you are working with it.

As a processor, you should return a product to the refrigerator as soon as you finish making it if you are not going to cook or smoke it immediately. After the product has been formulated, smoke and cook it to the required temperature, and then return the product to refrigeration. USDA has compliance guidelines for cooling cooked meats in Appendix B of the Performance Standards for the Production of Certain Meat and Poultry Products [FSIS Final Rule 95-033F].[1]

[1] Appendix B (online at www.fsis.usda.gov/OPPDE/rdad/FRPubs/95-033F/95-033F_Appendix%20B.htm).

Do not guess when determining the internal temperature of the product. ALWAYS use a calibrated thermometer. Temperature-abused sausage can permit excessive microbial growth and result in product spoilage and foodborne illness. Sausage makers must maintain a record of thermometer calibration and corrective actions taken each time a thermometer is calibrated. Thermometers intended for measuring hot temperature items must be calibrated in hot water, while those used for cold temperatures must be calibrated in ice water. A sample form to document thermometer calibration is shown in Table 2. Be sure to make it fit the procedures used in your processing plant.

Table 2. Sample Thermometer Calibration Log Form

Instructions: Thermometers used for temperature measurements MUST be regularly checked for accuracy. Thermometer accuracy must be checked using a standard calibrated thermometer traced against NIST standard and recorded on the Thermometer Calibration Log. The designated supervisor must verify and initial that employees are verifying accuracy of thermometers by reviewing and signing this log.

Date/ Time	Thermometer ID #	Method Used (Ice Slurry/ Boiling Point)	Thermometer Reading	Accurate (Yes/No)	Corrective Action Taken	Staff Initials	Verified By/Date

Cooking should be sufficient to pasteurize the product by raising the end-point product internal temperature enough to kill pathogens. Sausages are considered fully cooked when the center reaches an internal end-point temperature of 160° F.

Weights A calibrated weighing scale is the second most critical piece of item in sausage making. The proper ratio of beef to pork, or of lean meat to fat, is specific to certain types of sausage. Weighing should be more accurate than measuring using standard kitchen implements. The scales must be checked for accuracy using a standard weight according to the manufacturer's recommendation and should be recorded on the scale calibration log. The designated supervisor must verify and initial that his or her employees are verifying accuracy of scales by reviewing and signing this log. An example scale calibration log is provided in Table 3. Be sure to make it fit the procedures used in your processing plant.

Fat Content Different sausages have different amounts of fat. Avoid making the formula too lean as the sausage will be too dry and hard. Fresh pork sausage contains 30 to 45 percent fat. Smoked or roasted sausage contains 20 to 30 percent fat. Formulate the fat content just as you would the other ingredients in a sausage.

Storage The length of time a sausage can be stored depends on the type of sausage. Fresh sausage is highly perishable and will only last seven to 10 days under refrigeration (35° to 40° F). However, it may be frozen for four to six months if wrapped in moisture-vapor proof wrap (freezer paper) or freezer-weight zip bags. Smoked sausages that contain salt and nitrite and have been cooked, may last from two to four weeks under refrigeration. These types include smoked, Polish, cotto-salami and bologna. Summer sausages that have been fermented to produce the acidic tangy flavor are more durable and may be stored for several weeks in the refrigerator.

Table 3. Sample Weighing Scale Calibration Log Form

Instructions: Scales used to weigh ingredients will be checked for accuracy each time a product is made. The scale must be checked for accuracy using a standard weight according to the manufacturer's recommendation and recorded on the Scale Accuracy Log. The designated supervisor must verify and initial that employees are verifying accuracy of scales by reviewing and signing this log. This log should be maintained for a minimum of six months.

Date/ Time	Food Scale ID #	Standard Weight	Scale Reading	Accurate (Yes/No)	Corrective Action Taken	Staff Initials	Verified By/Date

Sanitation

Sanitation is the application and maintenance of procedures that establish an environmental state that promotes cleanliness and protects public health. Cleaning and sanitizing are among the most important activities in meat product plants, as these measures provide the necessary environment for proper meat handling and processing. There are direct links between inadequate sanitation and the contamination of meat and poultry products with pathogenic bacteria.

Sanitation and proper handling of meat and meat products are very important in sausage making. Bacterial contamination and foodborne illness are the main food safety concerns during raw meat handling and sausage making. In order to prevent the spread of pathogenic bacteria, the food preparation area and equipment must always be cleaned and sanitized before and after processing sausages.

USDA FSIS requires that meat and poultry establishments should develop and implement a written ***Standard Operating Procedure for sanitation (SSOPs)***.[2] Sanitation SOPs must address in detail all sanitation procedures for the facility, equipment, and utensils used in the establishment. An establishment's adherence to its written Sanitation SOP will demonstrate knowledge of and commitment to sanitation. Certain sanitary procedures must be addressed and maintained on a daily basis to prevent direct product contamination or adulteration. The USDA FSIS SSOPs are available online with guidelines that their inspectors must follow.

Food Manufacturing Facilities

The food manufacturing and/or processing environment can be a source of microbial contamination. Well-trained employees, well-designed process flow, and properly maintained facilities and equipment are fundamental to an effective cleaning and sanitation program. Efforts must be made to control the following in order to prevent contamination of products and food contact surfaces.

- Ceiling, walls, and floors must be smooth, sealed, and moisture-free. Drains should be operative and clean with no standing water.
- Pipes and insulation should be dry and well-maintained.
- Doors and windows should be tight-fitting and sealed to prevent intrusion by pests or dust.
- Overhead pipes, rails, and conveyors should be accessible, easy to clean, and free of condensate.

[2] USDA-FSIS Sanitation SOPs training materials for USDA inspectors, updated March 2014, can be found online at http://www.fsis.usda.gov/wps/wcm/connect/4cafe6fe-e1a3-4fcf-95ab-bd4846d0a968/13a_IM_SSOP.pdf?MOD=AJPERES

- Air supply should be dry and filtered.
- Production equipment should be free of recesses, open seams, gaps, protruding ledges, inside threads, inside shoulders, exposed bolts and rivets, and dead ends where product could build up and cause problems.
- Equipment should conform to cleaning and sanitizing standards and be designed for the specific job.
- Pallets should be well maintained, clean, and dry.
- Blowers and ducts must be cleaned on a routine basis and air filters should be changed as needed.
- Wet and dry vacuum canisters must be cleaned and sanitized after use.
- Refrigeration units and coolers must be cleaned and sanitized on a frequent routine.

Food Contact Surfaces

Properly cleaned and sanitized food contact surfaces are critical to ensuring a safe, sanitary operation. Use of recommended and approved cleaners and sanitizers will reduce levels of pathogenic organisms to prevent cross contamination of the product. Detergent cleaners suspend and help remove various food soils. Chemical sanitizers reduce the numbers of pathogens and other microorganisms.

The cleanup process must be completed in accordance with the following procedures:

- **Pre-cleaning—equipment and utensils shall be pre-flushed, presoaked, or scraped as necessary to eliminate excessive food debris. Clean all food contact surfaces; conveyors, peelers, collators, belts, gloves, slicers, and tables can be sources of direct product contamination.**
- **Washing—equipment and utensils shall be effectively washed to remove or completely loosen soils using a manual or mechanical means. Only approved chemicals are to be used in this process. Mix concentration according to manufacturer's recommendations. If using chlorine bleach, dilute 1-tablespoon chlorine bleach per gallon of water. Allow sanitized surface to air dry.**
- **Rinsing—washed utensils and equipment shall be rinsed to remove abrasives and to remove or dilute cleaning chemicals with water. Applying pressure with vigorous scrubbing greatly improves the removal of grease and other unwanted contaminants from the food contact surface.**
- **Sanitizing—after being washed and rinsed, equipment and utensils must be sanitized with an approved chemical by immersion, manual swabbing, brushing, or pressure spraying methods. Concentration and exposure times are important to ensure effectiveness of the chemical. Refer to the manufacturer's label for concentrations and times. Ensure that an appropriate chemical test kit such as chlorine, quaternary ammonia, iodine, etc., test strips are available and routinely used to ensure that accurate concentrations of the sanitizing solutions are being used.**

Cautionary Measures

- Avoid contaminating cleaned surfaces with aerosols or overspray.
- Review procedures for proper selection and application of detergents, sanitizers, temperatures, pressures, and flow rates.
- Use potable water rinse; without a potable water rinse, USDA regulations permit water mixed with:
    - 200 parts per million quaternary ammonia, or
    - 25 parts per million iodine, or
    - 200 parts per million available chlorine.
- Verify the effectiveness of sanitation procedures by microbiological monitoring.
- Document the results and any corrective action that is taken on the daily production log form.
- Do not limit sampling to flat surfaces. Record results of microbiological sampling on the production log. Re-clean any area that does not meet standards.

Non-Food Contact Surfaces

- Establish a regular schedule for cleaning and sanitizing based on results of microbiological monitoring.
- Clean and sanitize floors routinely. The frequency (e.g., daily, weekly) of cleaning depends upon the type of operation and whether the floor can be kept clean and dry.
- Use extensive cleanup and sanitation procedures following drain backup, prior to resuming the packaging operation.
- Never use a high pressure hose to free a blocked drain.
- Remove excess water from floors after cleanup.
- Wet/dry vacuums and squeegees are effective, but they should be routinely cleaned and sanitized.
- Avoid splashing or the formation of aerosols during the final stages of cleanup when equipment is clean and ready for sanitizing.
- Assure outer protective clothing of cleaning crew is properly washed, sanitized, and dried after use.

Cleaning Aids

- Wash and sanitize mops, squeegees, wet/dry vacuums, and condensate removal equipment after each use.
- Eliminate brooms made with absorbent materials. Use only brooms with plastic handles and bristles. Clean and sanitize them on a regular basis.
- Replace rags with disposable wipes and discard used scouring pads daily.
- Remove hoses from production area after cleanup. Clean, sanitize, and store on hooks off the floor.
- Always rinse and sanitize any cleaned object from the top downward to prevent re-contamination.

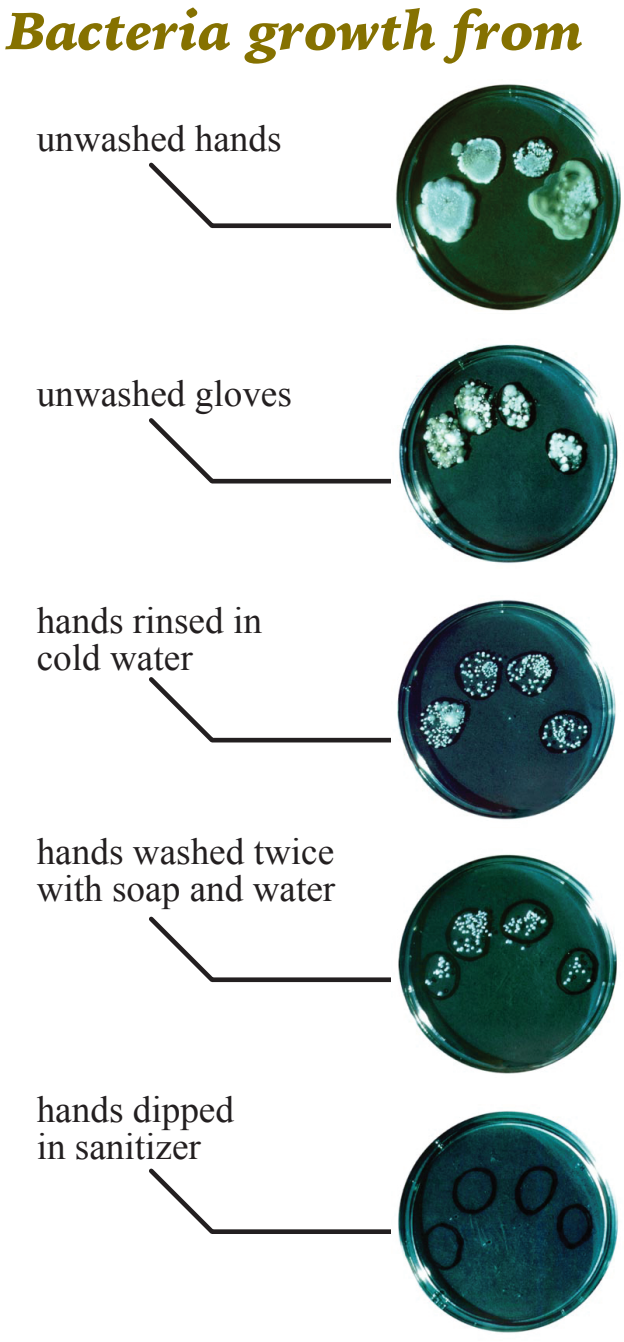
Personal Hygiene

Sausage makers are required to maintain high standards of food safety. To ensure safe, high quality products, sausage makers and their employees must follow all Good Management Practices (GMPs) listed:

- ***Cleanliness***
- ***Hands***—Hands can be a source of many microorganisms. Sausage makers and establishment employees MUST wash hands with soap and water located at a hand washing station:

  - before starting work;
  - after break time;
  - after lunch;
  - after using the washroom
  - after blowing nose or touching other body parts;
  - after handling garbage, or touching a pallet, skid, floor mat or picking up product from the floor; or
  - whenever your hands have become contaminated

  Always dry your hands using the disposable paper towels provided. Never dry or wipe your hands on your clothing as it may be contaminated with microorganisms.



- ***Nails***—Keep finger nails clean and neatly trimmed. Dirty nails are a popular place for bacteria to hide and grow. Nail polish is not permitted in the production area. The polish may flake off and contaminate the product. Bacteria also hide in cracks in the nail polish.
- ***Hair***—Wear a hair net in the production area. There must be no exposed or loose hair protruding from under a hairnet. Hair carries many microorganisms. (one hair follicle can contain up to 50,000 germs). Men with mustaches or beards must cover them fully with a beard net.
- ***Jewelry***—All jewelry, including watches, must be removed when entering the plant. Plain wedding bands without stones or settings are allowed. This is not only to protect products from contamination, but also to protect employees from injury and/or the loss of a valuable possession.

- ***Protective Clothing***—The protective clothing provided must be worn all time during sausage making and production and must be changed daily or as necessary throughout the day. Soiled clothing must be placed in the laundry receptacles provided. No soiled or dirty laundry is to be left in the production area.
  - One must not carry any personal items such as pens, knives, cell-phones, or other small articles in uniform pockets.
- ***Gloves***—Gloves must be worn all the time during production and processing. Plant personnel should wash hands before putting on a new pair of gloves. Gloves must be changed at every break, when torn, after touching garbage, and after touching your face or blowing nose, or as often as required to ensure food safety. Never carry extra gloves in pockets of work clothes due to the probability of gloves falling unnoticed into equipment or finished products. All used gloves must be disposed in the garbage cans provided.
- ***Illness and Injuries***—Sick/ill or injured personnel must NOT return to work. All cuts, sores, scratches, or other wounds must be covered with a waterproof covering such as Band-Aids. Gloves must be worn on top of Band-Aid or bandage.

Sausage makers must NOT cough or sneeze in the production, processing, and storage area. Block sneezes and coughs by using your shoulder or upper arm.

Personnel

- Plant management and supervision personnel must set a good example by strictly following established dress codes in the processing area.
- All employees must feel a sense of personal responsibility for the quality and safety of food products.
- All employees must be educated on correct food handling practices.
- Only properly trained line personnel should be used in operations that are most susceptible to post-processing contamination.
- Outer protective clothing (smocks, aprons, coats, etc.) should be changed daily, or more often if needed, and must be removed and stored properly when leaving processing areas.
- Hands must be washed and sanitized before starting work, upon returning to work stations, and after contacting floors or unclean surfaces.
- Waterproof footwear must be able to be cleaned and sanitized.
- Operator hand tools should not be stored in personal lockers. This equipment must remain in the processing area at all times and must be cleaned, sanitized, and dried before storage and again before use.
- Disposable plastic gloves, aprons, and sleeves should be used in processing areas. Change frequently when soiled. Do not use cotton gloves.

Prevention of Cross-Contamination

- Establish traffic patterns to prevent movement of personnel, meat containers, meat, ingredients, pallets, and refuse containers between raw and finished product areas.
- Avoid personnel working in both raw and processing (smokehouses, cook rooms) areas whenever possible. If employees must work in both areas, they must change outer clothing, wash hands, change gloves, and clean and sanitize footwear, hand equipment, and utensils before entering processing product areas.
- Identify employees working in raw or processing areas by color of hat or frock.
- Changing of outer clothing and washing and sanitizing tools and hands are required of all personnel, including maintenance personnel, before entering processing areas.
- Employees must change outer clothing before moving to processing product areas.
- Hallways common to raw and processing areas must be kept clean and dry. Frequent use of vacuum scrubbers is recommended.
- Restrooms, locker rooms, and lunchrooms should be kept clean and orderly.

Repackaged, Reworked, Returned, and Accidentally Contaminated Product

- The first priority is to design systems and operating practices that minimize losses from reworked or retained product and floor contamination.
- Repackaging of product from defective packages should be performed under controlled conditions that minimize contamination.
- Reworked product must always be fully cooked during reprocessing.
- Returned product that has been under producer control may be used after careful evaluation. Product outside producer control should not be accepted for return. Under no circumstances should such product be allowed to commingle with current production.

CRITICAL OPERATIONS

Equipment Wash Areas are an ideal environment for the spread of Listeria and other pathogenic and spoilage microorganisms. In order to prevent foodborne illness:

- Separate wash areas for raw and processed products must be maintained.
- Wash areas should be located where clean processing equipment does not cross raw-meat areas of the plant.
- The entire room must be cleaned and sanitized daily after processing is done.
- A visual pre-operations inspection of all processing areas should be done each morning before the start of processing and documented on the daily processing form. Any area that does not meet specifications must be re-cleaned and sanitized before processing can begin.

Slicing and Packaging Equipment

- Complete mechanical disassembly is required to prevent contaminants from accumulating and to allow thorough sanitation.
- All food contact surfaces must be cleaned and sanitized daily.
- Moisture must be controlled during production and breaks. Use disposable wipes soaked with sanitizers to clean work areas.
- Install conveyors that are easy to clean. They should be at a height that avoids contamination from floors and drains.
- Protective covers over control panels, motors and equipment, and other food contact surfaces may be a source of microbial contamination. When removed, all covered areas must be dried with disposable towels. Store covers in a clean, dry place when not in use.
- Heat shrinking equipment, including exhaust ducts, must be cleaned and sanitized daily to avoid spreading contamination from water and steam to packing lines.

Good Manufacturing Practices (GMPs) are programs that cover the basic steps and procedures for the control of operating conditions within establishments and ensure favorable conditions for the production of safe and wholesome food. GMPs are related to the entire manufacturing operation and are not process-specific. They include practices such as pest control, recall procedures, preventive maintenance, construction/ maintenance, and sanitation. GMPs are step-by-step descriptions that instruct individuals as to how, when, and what tasks are to be performed for a required GMP.

There is no substitute for keeping the tables, utensils, and ingredients clean and free from dirt and contamination. Use plenty of hot water and soap to wash. Then thoroughly rinse all food-contact surfaces, equipment, and utensils before and after processing sausages. Always keep your hands clean. These measures help to prevent spoilage and foodborne illness.

PATHOGENS OF CONCERN IN SAUSAGE MAKING

Trichinella spiralis, or the trichina parasite, is a major concern of sausage producers. Trichinosis, the sometimes deadly disease caused by consumption of the trichina parasite. Trichina parasite larvae commonly infest pork muscle, so most cases occur in persons who have consumed improperly treated or prepared pork products. Infection from consumption of sausage products typically occurs when a fresh sausage product has not been adequately cooked by the consumer or the sausage product has not been properly treated by the producer.

The microscopic size of the trichina parasite larvae (0.1 mm) makes it difficult to identify in a typical packinghouse operation. USDA FSIS requires that all pork be treated to destroy the parasite via heating, refrigeration, freezing, or curing.

In the sausage processing industry, heating is the most common treatment method. A temperature of 144º F is considered fatal to all trichinae organisms. This temperature is typically exceeded during the cooking process, however, products that are partially cooked at lower temperatures, such as smoked pork sausage, require additional treatment. These products typically undergo a formulation and curing

process designed to eliminate trichinae. The process includes controlling the size of the chopped meat in the product, ensuring a specific salt content, and specifying the length of time in a drying room at a specific temperature. Another form of treatment to eliminate trichina is freezing. These treatments are described in FSIS regulation § 318.10 and are found in the appendix of this document.

Escherichia coli O157:H7 (E. coli) is a bacterial contaminant of sausage and other meat products that can cause serious diarrheal illness, sometimes resulting in complications that can lead to death. The presence of E. coli in cooked sausages can be controlled by proper cooking temperatures and times. E. coli contamination of dry sausages can be reduced by closely controlling the fermentation heating process and the acid content and via post-fermentation heating to 145º F or above.

Proper hygiene, handling, and storage procedures are essential to control contamination in all types of sausage products.

Salmonella is a non-typhoidal pathogen, and salmonellosis is a leading cause of foodborne illness in the U.S. As with E. coli, salmonella organisms can be eliminated from cooked sausages by proper cooking processes. In dry sausages, the producer must follow a combination of processes to control the pathogen, including use of a fermentation starter culture, increased product temperatures during fermentation, and careful control of the product pH, cure, and salt content.

Product handling procedures must be designed and monitored to ensure that the finish product is not cross contaminated with the contaminants present in raw materials.

Listeria monocytogenes (Lm) is a bacterium found in soil and water that can contaminate meats. It can cause a serious infection in humans called listeriosis. The organism can be found in many food processing environments and has been isolated from floor drains and refrigeration drip pans. From these niches, the organism gets moved throughout the facility and can end up on food contact surfaces. Cross-contamination between raw and cooked product can also result in the presence of the bacteria on ready-to-eat products.

Detection of post-processing product contamination by L. monocytogenes can include sampling the processing lines and environment.

Sausage makers should consider the following elements in elimination of L. monocytogenes:

- Examine how all raw materials are being handled before they are cooked.
- Determine how raw material handling, processing procedures, and processing environment might affect L. monocytogenes levels in the product.
- Determine the handling and procedure of reworking practices on L. monocytogenes levels in the raw product.
- Examine product flow, processing patterns, and employee practices, and determine where opportunities for cross-contamination occur.

USDA FSIS has zero tolerance for L. monocytogenes in ready-to-eat products, such as hot dogs and luncheon meats, and conducts a monitoring program in facilities to test for the pathogen. Treatment of sausages to eliminate L. monocytogenes is similar to the steps to eliminate Salmonella, including thorough cooking and proper storage of the product.

Campylobacter jejuni is the most commonly reported bacterial cause of foodborne infection in the U.S. It is found in many foods of animal origin, including poultry and meats. Methods of controlling and reducing C. jejuni in processing facilities include forced air chilling of swine carcasses and implementation of standard hygienic practices.

Yersinia enterocolitica, the pathogen that causes the gastroenteritis illness, is another pathogen of concern.

ESTABLISHING A HACCP PLAN

USDA-inspected meat and poultry establishments must have a ***Hazard Analysis Critical Control Point (HACCP) plan***, which documents a systematic approach to process controls that will be followed at the facility. The plan must be designed to identify points in the production process where biological, chemical, or physical hazards, which may cause a food to be unsafe for consumption, are present. It must also describe the associated preventative measures, if any, that will be implemented to reduce or eliminate the potential problem. The food establishment develops its own HACCP plan so that it is unique to its processing facility and the products produced by the facility.

NOTE: A home sausage maker does not need to prepare a HACCP plan unless the product is to be sold commercially. Hygienic practices and sanitation guidelines must be followed.

The first step in establishing a plan is to assemble a HACCP team, including one person who is HACCP-trained. Food establishments have flexibility in how they write their HACCP plans, and each HACCP team is required to make its own decisions on how it will apply the HACCP system. Therefore, inspectors will see a wide variety in the HACCP plans encountered at processing facilities. Sausage makers or sausage production facilities are also required to maintain Sanitation Standard Operating Procedures (SSOPs) and Good Manufacturing Processes (GMPs) that work with your HACCP plan.

Steps in Developing a HACCP Plan

Product Description The sausage maker or the processor must describe each sausage product for each process category that is being manufactured or produced. Small and very small processors should provide reference to the product name, the intended consumer, how the product is used, the type of package, the shelf life, the display temperature, where and how the product will be displayed, and the labeling. Ingredients used should be identified and listed in order of predominance.

Process Flow Diagram Sausage makers should produce a simple description of all the steps in the sausage production process and document the process flow by physically walking through each step of the production and processing. This information is then developed into a diagram of the sausage production steps. An accurate description of the process is necessary to be able to do a proper hazard analysis. The steps in the process flow diagram should also include any reworking or recycling of materials. The process flow diagram should be confirmed by a person or persons with sufficient knowledge of the operation to ensure that it is accurate and reflects what is actually happening.

Hazard Analysis The first part of the hazard analysis is an evaluation of the specific food process and manufacturing establishment. The evaluation considers the effect of a wide range of factors on the safety of the food. The potential risk and severity of each hazard must be assessed and preventative measures must identified to prevent any hazards introduction at any step of the production and processing.

Hazards include biological, chemical, or physical properties that may cause a food to be unsafe for consumption. Hazards should be identified specifically when necessary to identify specific controls for the particular hazard/product combination. Examples of specific hazards are: Listeria monocytogenes in ready-to-eat sausage products and metal in clipped sausages.

The sausage makers and processors should identify the hazards that are reasonably likely to occur in each input, considering any supplier assurances or agreed specifications, and supplier performance.

Critical Control Point Determination A critical control point (CCP) is a step at which control can be applied and is essential for food safety as defined by a regulatory limit or an operator-defined limit. The sausage processors should determine whether there are any CCPs for the process.

Establish Critical Limits. Critical limit means a criterion that separates acceptability from unacceptability at a critical control point. The operator must define and justify critical limit(s) for each CCP. In some cases, more than one critical limit may be needed at a particular step. Parameters often used include temperature, time, moisture level, pH, and water activity.

Critical limits must be:

- Measurable and should be linked to the achievement of a regulatory limit or operator-defined limit;
- Appropriate to the specific operation and product; and
- Monitored in real time to ensure ongoing effectiveness of the particular process step to achieve a specified level of control.

Monitoring is the scheduled measurement of a critical limit(s) at a CCP. Most monitoring procedures involve methods that provide immediate results so that loss of control at the CCP can be detected quickly and appropriate corrective action can be taken to regain control. The monitoring frequency selected must ensure adequate and consistent control. Monitoring may be continuous or be based on a statistical sampling plan.

Monitoring procedures should include the following information:

- Person responsible for monitoring;
- Monitoring method;
- Monitoring frequency and sampling regime; and
- Records to be kept.

Corrective Action These are actions or procedures taken when a critical limit set for the safe sausage production is not met. Each corrective action taken at any step during sausage processing and production must be documented to reflect what corrective measures were taken to correct the process or bring the process under control.

Establish Verification Procedures The sausage makers are required to establish verification procedures to ensure that the HACCP system is working effectively. The frequency of verification should be sufficient to confirm that the HACCP system is consistently working correctly.

Record Keeping Just as you keep a copy of a good recipe, you should keep notes on the formulation and processing procedures of your favorite smoked and cooked sausage (see Appendix). Ingredients, times, temperatures, and end results should be noted. This will help to make a better sausage the next time.

Create a daily production log sheet where all batch codes, production processing and output, any corrective actions taken, and final disposition of that batch of product can be traced. This log must be accurately filled out on a daily basis to provide documentation in the event of a recall.

SAUSAGE RECIPES

FRESH SAUSAGE RECIPES
Fresh Pork Sausage
Fresh Chicken Sausage
Fresh Thuringer
Liver Sausage
Smoked Pork Sausage
Venison or Game Sausage
Italian Style Pork Sausage
Bratwurst
Beef Breakfast Sausage

COOKED SAUSAGE RECIPES
Polish Sausage
Italian Style Cotto-Salami
Kosher or All Beef Sausage
Coarse Ground Bologna

FERMENTED SAUSAGE RECIPES
Summer Sausage
Pepperoni
Dry Beef Salami

LUNCHEON LOAF RECIPE
Spiced Luncheon Loaf

Fresh Pork Sausage

Fresh pork sausage is a mixture of pork meats, which have been ground or chopped, salt, and spices, but has no added water or extenders. Fat content usually ranges from 35 to 50 percent depending upon individual preference. Pre-mixed seasonings are also available. Ingredient portions may be divided for smaller batches.

Ingredients:

110 pounds of pork trimmings (60 percent lean)

Directions:

Mix spices with trimmings. Grind once through 3/8-inch plate, and then through 3/16-inch plate. Use in bulk form, stuff in natural casings (pork rounds) or collagen casings.

Mild

	Measurement	Weight
salt	3 3/4 c.	1 lb. 14 oz.
sugar	1 c.	7 oz.
black pepper	1 c.	5 oz.
rubbed sage	1 c.	2 oz.

Hot (add to above ingredients)

	Measurement	Weight
crushed dried pepper	3 3/4 c.	1 lb. 14 oz.
ground red pepper	1 c.	7 oz.

Fresh Chicken Sausage

Ingredients:

1.5 pounds of ground chicken breast

Directions:

Heat a small nonstick skillet over medium heat. Add butter and melt. Add apples and onions and season with a little salt, pepper, and fennel seeds. Gently sauté the mixture for 5 minutes to soften, and then remove from heat to cool.

Place ground chicken in a bowl and season with salt and pepper, poultry seasoning, allspice, paprika, and a healthy drizzle of extra-virgin olive oil. Add in the apples, onions, and fennel. Then mix in the sausage. Score meat into 4 sections and form 3 small, thin patties from each section, 2 1/2 inches across, 12 small patties total. Cook patties 3 to 4 minutes on each side and serve warm.

	Measurement	Weight
butter	1 tsp.	0.17 oz.
green apple, finely chopped	1	
small onion, finely chopped	1	
fennel seed	1 tsp.	0.25 oz.
poultry seasoning	1 1/2 tsp.	0.4 oz.
allspice	1 tsp.	0.25 oz.
sweet paprika	1 tsp.	0.25 oz.
salt and pepper	to taste	
Extra-virgin olive oil	for drizzling	

Fresh Thuringer

Ingredients:
20 pounds of lean meat
5 pounds of pork or beef fat

	Measurement	Weight
sugar	4 Tbsp.	1.76 oz.
cold water	1 qt.	32 oz.
salt	3/4 c.	8 oz.
ground white pepper	3/4 c.	2.8 oz.
powdered mustard	5 tsp.	0.25 oz.
commercial cure (6.25% nitrite)*	2 Tbsp.	1.1 oz.
sodium erythorbate or ascorbate	1 1/2 tsp.	0.22 oz.
liquid smoke, diluted in 2 cups water (optional)	1 to 2 Tbsp.	1 to 2 oz.

Directions:
Cut lean meat and fat into 1-inch squares or grind through a coarse (1/2-inch) plate. Sprinkle ingredients over meat and mix. Grind through a 1/4-inch plate while adding water, and then regrind through a 3/16-inch plate. Mix for 6 minutes, and then stuff into hog casings and link.
Liquid smoke (1 to 2 ounces diluted with a pint of water) is sometimes added to replace the application of natural smoke. Add the diluted liquid smoke at the end of the 6-minute mixing period and before stuffing into casings, if desired.
Cook thuringer in 170º F water or in smokehouse at 185º F until internal sausage temperature is 152º F. Chill to an internal temperature of 100º F in cold water. Hang at room temperature until surface is dry (about 30 minutes) and then refrigerate or freeze. Thuringer can also be served hot right out of the 170º F water or 185º F smokehouse.

Liver Sausage

Ingredients:
12.5 pounds of liver
7 pounds of lean meat
2.5 pounds of pork or beef fat
3 pounds bacon end pieces

	Measurement	Weight
fresh onions, peeled and chopped		1.5 lb.
nonfat dry milk	2 1/4 c.	13 oz.
salt	7/8 c.	9 oz.
ground white pepper	6 Tbsp.	1.5 oz.
commercial cure (6.25% nitrite)*	2 Tbsp.	1.1 oz.
sodium erythorbate or ascorbate	1 1/2 tsp.	0.21 oz.

Directions:
Fry liver until it is about half-cooked. Grind liver, lean meat, and fat through a coarse (1/2-inch) plate. Chop onions and season by sprinkling ingredients over the meat and mixing.

Grind through a 1/8-inch plate. Mix 6 minutes and stuff into natural or artificial casings, 2 to 3 inches in diameter.

Cook in water at 170º F or in a 185º F smokehouse until internal temperature of sausage reaches 152º F. Immediately place sausage in cold water until internal temperature of sausage is 100º F. Rinse briefly in hot water to remove grease. Hang at room temperature until surface is dry (about 30 minutes). Store in refrigerator.

Smoked Pork Sausage

Smoked fresh pork sausage is a traditional "home style" product. It is cold smoked in the smokehouse for several days. During this process a natural fermentation occurs, which produces the characteristic tang or flavor of the product. An internal temperature of 140º F is required to kill any trichina that may be present.

Ingredients:

110 pounds of pork trimmings (60 percent lean)

Directions:

Place the stuffed sausage on racks or smoke sticks and hang in the cooler for 36 to 48 hours. Place the sausage in the smokehouse. Heat to 100–110º F, with dampers open, until the sausage surface is tacky to touch. Close dampers and introduce smoke. Smoke for 2 to 6 hours, depending upon color desired. Raise smokehouse temperature to 125º F after 2 hours of smoking, 145º F after 3 hours. Continue smoking until the internal product temperature reaches 140º F. Maintain a relative humidity of approximately 40 percent in the smokehouse during smoking.

Mild

	Measurement	Weight
salt	3 3/4 c.	1 lb. 14 oz.
sugar	1 c.	7 oz.
black pepper	1 c.	5 oz.
rubbed sage	1 c.	2 oz.

Hot (add to above ingredients)

	Measurement	Weight
crushed dried pepper	3 3/4 c.	1 lb. 14 oz.
ground red pepper	1 c.	7 oz.

Venison or Game Sausage

Ingredients:

25 pounds of lean venison or trimmings
25 pounds of fat pork (jowls or fresh bellies)

Directions:

Cut lean venison and pork into small pieces. Then add spices and mix. Grind twice through 1/8-inch or 3/16-inch plate. Sausage may be stuffed into casings, made into patties, smoked, or used in bulk form.

	Measurement	Weight
salt	2 c.	1 lb.
black pepper	12 Tbsp.	3 oz.
ginger	5 Tbsp.	1 oz.
rubbed sage	8 Tbsp.	1 oz.
crushed red pepper (optional)	5 Tbsp.	1 oz.
ground red pepper (optional)	5 Tbsp.	1 oz.

Italian Style Pork Sausage

This is a coarsely ground, fresh sausage that is normally pan-fried or broiled. The most popular style is broiled in a large spiral roll (snail like) on a grill until tender.

Ingredients:

10 pounds of lean pork trimmings (65 percent lean)

Directions:

Mix the seasonings thoroughly with the trimmings. Grind the pork trimmings through a 1/4-inch or 3/8-inch plate. Stuff into natural hog casings or size 30–36 mm collagen casings. Hang overnight in 38º F refrigeration for spices to marinate.

	Measurement	Weight
salt	4 3/4 Tbsp.	2.4 oz.
fennel seed (anise may be substituted)	2 1/2 Tbsp.	0.4 oz.
crushed red pepper	2 Tbsp.	0.4 oz.
ground black pepper	1 Tbsp.	0.2 oz.
white pepper	1 Tbsp.	0.2 oz.
paprika	Tbsp.	0.2 oz.
coriander (optional)	1 1/4 Tbsp.	0.2 oz.
chopped fresh parsley (optional)	2 Tbsp	0.4 oz.
garlic clove, minced (optional)	1	

Bratwurst

Bratwurst is a typical fresh German style sausage. It is a mild sausage and goes well as a main dish.

Ingredients:

10 pounds of pork trim (70 percent lean)

Directions:

Grind pork through 1/4-inch plate and mix with salt, water, and spices. Stuff into natural hog casings or 32 mm collagen casings. Steam or water cook at 170º F to an internal temperature of 155º F. Store under refrigeration.

	Measurement	Weight
water/ice	1 c. (water)	3 lb. (ice)
salt	6 1/2 Tbsp.	3.2 oz.
ground white pepper	1 1/2 Tbsp.	0.3 oz.
sugar	1 3/4 tsp.	0.3 oz.
mace	1/2 Tbsp.	0.1 oz.
onion powder	1 Tbsp.	0.2 oz.

Polish Sausage (Kielbasa)

Polish sausage is made of coarsely ground lean pork with some added beef. The basic spices for this well-known sausage are garlic and marjoram.

Ingredients:

8 pounds of pork shoulder or lean trim (75 percent lean)
2 pounds of beef trimmings (80 percent lean)

Directions:

Grind beef and pork through 1/4-inch plate. Add spices and water. Then mix thoroughly. Grind through 3/16-inch plate. Stuff into natural hog casings and hold overnight for cure to react. Smoke at 90º F to 100º F for 2 hours. Raise temperature gradually to 165º F to 170º F in smokehouse and cook until internal product temperature reaches 150º F.

NOTE: Beef gives this product a deeper red color and improves the product consistency and appearance.

	Measurement	Weight
ice or water		4.8 oz.
salt	7 1/4 Tbsp.	3 oz.
sugar	4 Tbsp.	1.6 oz.
white pepper	2 1/2 Tbsp.	0.5 oz.
mustard seed	2 1/4 tsp.	0.3 oz.
marjoram	4 tsp.	0.2 oz.
garlic powder	1 1/12 tsp.	0.1 oz.
nutmeg	2 1/2 tsp.	0.2 oz.
nonfat dry milk	1 3/8 c.	5.6 oz.
sodium nitrate*	1-1/4 tsp.	0.2 oz.
sodium nitrite* (optional)	1/8 tsp.	0.025 oz.

Italian Style Cotto-Salami

This is a cooked, mild -flavored Italian salami with a characteristic flavor. It is made of coarsely chopped pork, chopped beef, and pork trimmings, flavored with garlic, and stuffed into large diameter casings.

NOTE: The sodium nitrite may be substituted for the sodium nitrate for more rapid cure color development and elimination of the overnight cure time.

Ingredients:

4 pounds of lean beef trimmings
3 pounds of extra lean pork
3 pounds of regular pork trimmings

Directions:

Grind the lean beef through a 3/8-inch plate and then through a 1/4-inch plate. Grind extra lean pork and regular pork trimmings through a 1/2-inch plate and then through a 3/16-inch plate. Place all meat in the mixer; add cure and seasoning; and mix well. Stuff into No. 6 fibrous casings and hang overnight in 38º F cooler. Remove in the morning and allow product to stand at room temperature for 2 to 3 hours. Place in a 110º F smokehouse and smoke until the desired color is obtained. The product may be finished in either of two ways:

1. Smoked-cooked product—raise temperature gradually until desired color is obtained and an internal temperature of 150º F is reached. Shower with cold water until internal temperature of 120–130º F is reached. Allow to dry at room temperature before placing in cooler.
2. Water-cooked product—when desired color is obtained in the smokehouse, place sausage into a vat type water cooker and process until an internal temperature of 150º F is achieved.

The smoked-cooked product is a higher quality product with better color and shelf-life due to the drier nature of the product.

	Measurement	Weight
salt	9 Tbsp.	4.8 oz.
non-fat dry milk	1 1/4 c.	4.8 oz.
sugar	5 Tbsp.	2.0 oz.
nutmeg	1 1/4 tsp.	0.1 oz.
ground cardamom	1 3/4 tsp.	0.1 oz.
cracked black pepper	3 Tbsp.	0.6 oz.
garlic	1 tsp. (powder); to taste (fresh)	0.1 oz. (powder); 0.2 oz. (fresh)
sodium or potassium nitrate*	1 1/4 tsp.	0.2 oz.
sodium nitrite* (optional)	1/8 tsp.	0.025 oz.

Kosher or All Beef Sausage

For Kosher products, use Kosher ingredients.

Ingredients:

7.5 pounds of fresh boneless beef chucks (85 percent lean)
2.5 pounds of fresh boneless beef plates (50 percent fat)

	Measurement	Weight
salt	8 Tbsp.	4.0 oz.
sugar (dextrose)	2 Tbsp.	0.8 oz.
ground white pepper	3 Tbsp.	0.6 oz.
garlic, mashed and peeled or garlic powder	1 tsp.	0.1 oz.
paprika	1 1/2 Tbsp.	0.3 oz
ground coriander	2 1/2 tsp	0.125 oz
sodium nitrate* (saltpeter)	1 1/4 tsp.	0.2 oz.
sodium nitrite* (optional)	1/8 tsp.	0.025 oz.

Directions:

Grind beef chucks through 1/8-inch plate and beef plates through 1/4-inch plate. Combine meat ingredients; add salt, dextrose, cure, and seasoning; and mix well for 5 minutes. Transfer to stuffer and stuff in cellulose of fibrous casings 3 to 4 inches in diameter or large beef casings. Place in cooler at 40º F for 36 hours so cure can react with meat. Remove from cooler and allow product to stand at room temperature for 2 hours. Moisten surface by showering briefly with cool water before placing in 90–100º F smokehouse. Hold at this temperature while smoking for 4 hours, then gradually raise the temperature to 165–170º F, holding at this temperature until a minimum internal temperature of 152º F is reached. Total smoking time will depend upon the size of casing used. It is important that internal temperatures be checked frequently. Total cooking time will be 12 to 14 hours. Remove from smokehouse and shower in cold water until internal temperature is reduced to 120–130º F. Allow product to stand at room temperature for 2 to 3 hours before placing in a dry cooler.

Fresh Coarse Ground Bologna (Country Style)

Bologna is named after the city of Bologna, Italy, where it was first produced. It is normally stuffed into large-diameter cellulose or fibrous casings (No. 4 or 6) and natural beef middle or beef bung casings. The following formulas may be changed in meat content depending upon meats available.

Ingredients:

Meat Formula No. 1

3.2 pounds of regular pork trimmings (60 percent lean, 40 percent fat)
3.2 pounds of lean pork trimmings (80 percent lean, 20 percent fat)
3.6 pounds of lean beef trimmings (80 percent lean, 20 percent fat)
1 2/3 cups (6.4 oz.) of dried skim milk (optional)

Meat Formula No. 2

8 pounds of lean beef chucks
2 pounds of. regular pork trimmings

	Measurement	Weight
ice or water	2 pts.	2 lb.
salt	1/2 c.	4.4 oz.
sugar	2 Tbsp.	0.8 oz.
ground white pepper	2 Tbsp.	0.4 oz.
coriander	2 tsp.	0.1 oz.
mace	1/2 Tbsp.	0.1 oz.
sodium or potassium nitrate* (saltpeter)	1 1/4 tsp.	0.2 oz
onion, fresh grated (optional)	1/8 tsp.	2.4 oz.
garlic, fresh grated (optional)		0.1 oz.

Directions:

Grind meat through a 1/4-inch plate. Add seasonings, cure (saltpeter dissolved in a small amount of water), and ice to meat ingredients and mix thoroughly. Stuff mix into casings of type and size desired and hang overnight in 38º F cooler. Product should then be placed in a smokehouse and smoked at 110–120º F until good color develops. The bologna is then cooked in the smokehouse by gradually raising the smokehouse temperature to 165–170º F and cooking until an internal temperature of 150º F is reached. The product may be water cooked after smoking by placing the bologna in a water bath at 160–165º F and cooking until an internal temperature of 150º F is reached. After cooking, the bologna should be placed in a cold water bath or shower for 12 to 15 minutes or until the internal temperature is reduced to 90–100º F. Place the product under refrigeration until used.

Summer Sausage

Summer sausage refers to all dry sausages. Its name comes from the fact that it can be preserved for a period of time without refrigeration; therefore, it was popular in the summertime prior to the days of home refrigeration. Semi-dry sausages are of the same type, but are not dried to such low moisture content. This sausage is of the semi-dry type and requires refrigeration.

	Measurement	Weight
salt	10 Tbsp.	4.8 oz.
sugar	2 Tbsp.	0.9 oz.
ground black pepper	2 Tbsp.	0.4 oz.
ground allspice	1 1/4 tsp.	0.1 oz.
nutmeg	1 1/4 tsp.	0.1 oz.
vinegar	3 tsp.	0.5 oz.
starter culture (optional, frozen prepared bacterial culture)	1.2 tsp.	0.2 oz.
coriander	3 1/4 tsp.	0.2 oz.
garlic powder	1/4 tsp.	0.05 oz.
sodium or potassium nitrate* (saltpeter)	1 1/4 tsp.	0.2 oz.

Ingredients:

6 pounds of lean pork trimmings
4 pounds of beef trimmings (sinews removed)

Directions:

Grind trimmings through 3/16-inch or 1/4-inch plate. Mix the ground materials with the seasonings and saltpeter. Pack sausage in 6-inch deep pans and cure at 40–45º F for 2 to 3 days. Regrind through 1/8-inch place and stuff in No. 4 fibrous casings or 2-1/2-inch casings. Place in the smokehouse at 90–110º F and give a heavy smoke for 6 to 8 hours. Raise the temperature gradually to 165–170º F and cook until the internal temperature reaches 145–150º F. Remove, shower with cold water, allow to dry, and place sausage in refrigeration.

Pepperoni

The traditional style pepperoni is not smoked, but is a dry fermented sausage. However, many pepperoni products presently on the market for the pizza trade are smoked and are processed for much shorter times by cooking to an internal temperature of 140º F in the smokehouse. This is required for trichina treatment.

	Measurement	Weight
salt	11 Tbsp.	5.6 oz.
sugar	6 Tbsp.	2.4 oz.
sweet paprika	6 Tbsp.	1.2 oz.
black pepper	3 Tbsp.	0.6 oz.
ground red pepper	2 Tbsp.	0.4 oz.
whole fennel seed	3 Tbsp.	0.5 oz.
sodium nitrate*	1 1/4 tsp.	0.2 oz.

Ingredients:

20 pounds of lean meat
5 pounds of pork or beef fat

Directions:

Carefully trim all meats to ensure that all sinew and large pieces of connective tissue have been removed. Grind all meat through a 1/2-inch plate and then through a 1/8-inch plate. Add remaining ingredients and mix for 5 minutes or until these ingredients are uniformly distributed. Stuff into 36–44 mm animal casings, or if for slicing, use fibrous casings 1 1/2 to 2 inches in diameter.

Hold the stuffed product for 2 to 3 days at 38º F. Transfer to a green room and hold for 48 hours (65º F and 70 percent relative humidity). Smoke for 60 hours at 90º F using a dry smoke until a good reddish-brown smoke color has developed. Raise the relative humidity to 80 percent and smoke until the desired color has developed. Hold the smoked product in a drying room for 21 days at 50º F and 70 percent relative humidity. Shrinkage should be about 35 percent.

Dry Beef Salami

Dry beef salami is a dry sausage if the drying cycle is completed. When completely dried, it is shelf stable and considered a high quality product.

Ingredients:

9 pounds of beef trimmings (85 percent lean)
1 pound of pork or beef kidney fat or fat meat

	Measurement	Weight
salt	11 Tbsp.	5.6 oz.
sugar	3 Tbsp.	1.2 oz.
white pepper	5 Tbsp.	1 oz.
mace	1 1/2 tsp.	0.1 oz.
ginger	11/2 tsp.	0.1 oz.
starter culture (optional, frozen bacterial culture)	0.2 oz	0.2 oz.
sodium nitrate* (saltpeter)	1 1/4 tsp.	0.2 oz.
sodium nitrite* (optional)	1/8 tsp.	0.025 oz.

Directions:

Grind beef through a 1/8-inch plate and fat through a 1/4-inch plate. Mix all the ingredients for 5 minutes or until a good distribution of the fat and lean is apparent. Store the mix in trays 6 inches deep for 2 to 4 days at 40–45º F. Grind meat through 1/8-inch plate. Stuff into 3-inch fibrous casings or suitable collagen casings. Hold stuffed product for 20 days at 50–60º F and 60 percent relative humidity. This product may be smoked/cooked to internal temperature of 140º F to shorten drying cycle. The holding time or the cooking requirement is necessary to kill trichina in the pork, if used. Fully drying a sausage requires approximately 90 days, and the product loses about 35 percent moisture.

Spiced Luncheon Loaf

This is an excellent all-meat loaf for use as a cold cut or sandwich meat.

Ingredients:

10 pounds of extra lean pork trimmings (80 percent lean)

	Measurement	Weight
clear corn syrup	1 1/2 Tbsp.	1.0 oz.
salt	9 Tbsp.	4.4 oz.
white pepper	3 Tbsp.	0.6 oz.
mace	1 Tbsp.	0.2 oz.
nutmeg	1 1/4 tsp.	0.1 oz.
sodium or potassium nitrate* (saltpeter)	1 1/4 tsp.	0.2 oz.
sodium nitrite* (optional)	1/8 tsp.	0.025 oz.

Directions:

Grind pork trimmings through 1/4-inch plate. Place ground meat in mixer, add balance of ingredients, and mix thoroughly. Fill in molds or loaf pans, or stuff in No. 6 fibrous casings. Hold overnight in a 38º F cooler to cure. Water cook at 160–165º F until an internal temperature of 150º F is reached. Allow to cool at room temperature, remove from molds and place in refrigeration for storage.

***CAUTION: Use only the prescribed amounts of sodium nitrite or nitrate as these are toxic at high levels.**

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APPENDIX

Sample Record Keeping Chart

Date	Product / Recipe	Time / Temp 1	Time / Temp 2	Time / Temp 3	Time / Temp 4	Time / Internal Temp Out	Time Smoked / Cooked	Initials
10/14	Polish, no garlic	2:10 pm 100º F	4:10 pm 135º F	6:10 pm 155º F	7:10 pm 170º F	7:42 pm 152º F probed	4 hrs	JMC
Comment: Dry day, no water pan in smoker, shrink caused casing to wrinkle								
11/18	Smoked turkey	8:00 am 140º F	12 noon 150º F	12:20 pm 160º F	1:20 pm 190º F	9:00 pm 165º F	11 hrs	BWF
Comment: Probe inserted into breast muscle to determine temp, some shrinkage								
Comment:								

Calculations

Conversion to parts per million (PPM)

1	ppm	=	1/1,000,000	= 0.000001	= 0.0001%
10	ppm	=	10/1,000,000	= 0.00001	= 0.001%
200	ppm	=	200/1,000,000	= 0.0002	= 0.02%
5000	ppm	=	5000/1,000,000	= 0.005	= 0.5%
20,000	ppm	=	20,000/1,000,000	= 0.02	= 2.0%

Conversely, the conversion of percent (parts per hundred) to ppm is performed as follows:

0.02% = 0.0002
0.0002 × 1,000,000 = 200 ppm

Spice Conversion Chart

Name of Spice	Conversion	Name of Spice	Conversion
Allspice, Whole	1 oz. = 4 - 5 Tbsp.	Honey	1 oz. = 1 tsp.
Anise, Ground	1 oz. = 4 Tbsp.	Mace	1 oz. = 4 Tbsp.
Basil Leaf	1 oz. = 8 Tbsp.	Marjoram, Powdered	1 oz. = 6 - 8 Tbsp.
Basil Powder	1 oz. = 6 Tbsp.	Marjoram, Whole	1 oz. = 6 - 8 Tbsp.
Bay Leaf, Ground	1 oz. = 5 Tbsp.	MSG	1 oz. = 2.2 Tbsp.
Caraway Powder	1 oz. = 5 Tbsp.	Mustard Seed, Ground	1 oz. = 4 Tbsp.
Caraway Seed	1 oz. = 3 Tbsp.	Mustard Seed, Whole	1 oz. = 3 Tbsp.
Cardamom	1 oz. = 4 Tbsp.	Non-Fat Dry Milk	1 oz. = 3 - 3 1/2 Tbsp.
Cardamon, Ground	1 oz. = 5 Tbsp.	Nutmeg, Ground	1 oz. = 3 Tbsp.
Celery Powder	1 oz. = 3 - 4 Tbsp.	Onion Flakes	1 oz. = 3 Tbsp.
Celery Seed, Ground	1 oz. = 4 Tbsp.	Onion Powder	1 oz. = 3 - 4 Tbsp.
Chili Powder	1 oz. = 4 Tbsp.	Onion Salt	1 oz. = 2 Tbsp.
Cinnamon	1 oz. = 3 1/2 Tbsp.	Oregano Seed	1 oz. = 8 Tbsp.
Cinnamon	1 oz. = 3 Tbsp.	Oregano Leaf	1 oz. = 9 Tbsp.
Cloves, Ground	1 oz. = 4 Tbsp.	Paprika, Ground	1 oz. = 4 Tbsp.
Coriander, Ground	1 oz. = 4- 5 Tbsp.	Parsley Flakes	1 oz. = 16 Tbsp.
Coriander Seed	1 oz. = 5 Tbsp.	Pepper, Black	1 oz. = 4 Tbsp.
Corn Syrup, Solid	1 oz. = 2 Tbsp.	Pepper, Cayenne	1 oz. = 4 Tbsp.
Cumin, Ground	1 oz. = 4 Tbsp.	Pepper, Coarse	1 oz. = 4 Tbsp.
Cure	1 oz. = 2 Tbsp.	Pepper Flakes	1 oz. = 5 Tbsp.
Curry, Ground	1 oz. = 4 Tbsp.	Pepper, White	1 oz. = 4 Tbsp.
Dextrose, Powdered	1 oz. = 3 Tbsp.	Pepper, Whole	1 oz. = 3 Tbsp.
Dill, Whole	1 oz. = 4 Tbsp.	Pickling Spice	1 oz. = 3 Tbsp.
Fennel Seed, Cracked	1 oz. = 3 Tbsp.	Rosemary, Ground	1 oz. = 7 Tbsp.
Fennel Seed, Ground	1 oz. = 3 - 4.5 Tbsp.	Sage, Dried	1 oz. = 8 - 10 Tbsp.
Fennel Seed, Whole	1 oz. = 4 Tbsp.	Salt	1 oz. = 2 Tbsp.
Fermento (Starter Culture)	1 oz. = 4 Tbsp.	Soy Protein	1 oz. = 3 Tbsp.
Garlic	1 Clove = 1/8 tsp.	Sugar, Brown	1 oz. = 1 1/2 Tbsp.
Garlic, Granulated	1 oz. = 3 Tbsp.	Sugar, Granulated	1 oz. = 1 1/2 Tbsp.
Garlic, Powder	1 oz. = 3 Tbsp.	Thyme, Whole	1 oz. = 7 Tbsp.
Gelatin	1 oz. = 3 Tbsp.	Thyme, Ground	1 oz. = 3 1/2 - 4 Tbsp.
Ginger, Ground	1 oz. = 4 Tbsp.	Tumeric Powder	1 oz. = 3 1/2 Tbsp.

Glossary

Antioxidant. A substance that retards oxidation. Antioxidants are added to meat and poultry products to prevent oxidative rancidity of fats.

Binder. An additive used to improve the binding properties of lean meat or poultry or meat and/or poultry mixtures. Binders have strong affinity for water; therefore, misuse of binders may cause the product to be adulterated with excess water.

Brine Solution. An amount of water that contains salt either alone or with other ingredients; often referred to as a pickle.

Comminuted. Ground meat, poultry, meat byproducts, or poultry byproducts; finely comminuted meat, poultry, meat byproducts, or poultry byproducts are often referred to as emulsified.

Control. Take all necessary actions to ensure and maintain compliance with standards and other applicable criteria.

Control Measures. Any action and activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

Corrective Action. Any action to be taken when the results of monitoring at a CCP indicate a loss of control.

Critical Control Point (CCP). A step at which control can be applied; is essential to prevent or eliminate a hazard or reduce it to an acceptable level.

Critical Limit. A criterion that separates acceptability from unacceptability at a critical control point.

Cure. To add salt or salt brine and nitrite and/or nitrate, with or without sugar and other ingredients, to a meat or poultry product.

Cure Accelerator. Ingredients in cure mixture, such as sodium erythorbate and sodium ascorbate, that speed up the curing process for faster color development by rapid conversion of nitrates into nitrites.

Cured, Comminuted Products. Products consisting of coarsely or finely ground meat and/or poultry and cure ingredients mixed together (bologna, turkey salami, pepperoni, pepper loaf, etc.).

Cured, Dry Products. Products that have dry or powdered cure ingredients directly applied to the surface of the meat or poultry (ham, pork shoulder, pork belly, etc.).

Cured, Pickled Products. Products that are pumped or massaged with, or immersed in, a pickle solution of cure ingredients (ham, corned beef, poultry breasts, etc.).

Dry, Salt-Cured Products. Products that have had a pickle solution of cure ingredients directly pumped into the muscle tissue (not through the circulatory system) before having the dry or powdered cure ingredients applied to the surface of the meat or poultry.

Extender. An additive that increases the weight and changes the texture of meat and poultry products, e.g., cereal, starches, etc.

Glossary (continued)

HACCP - Hazard Analysis and Critical Control Point. A system that identifies, evaluates, and controls hazards that are significant for food safety.

Hazard. A biological, chemical, or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Hazard Analysis. The process of collecting and evaluating information on hazards and/or conditions that lead to the presence of hazards in order to decide which are significant for food safety and therefore should be addressed in the HACCP plan.

Monitoring. The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

Process Flow Diagram. A systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food.

Pickle. Any brine, cure, vinegar, or spice solution used to preserve or flavor food.

Restricted Ingredient. A product component that must be used in some required amount or percentage when the product is formulated or be a component of the finished product in an amount no greater than a specified maximum amount or percentage; and/or may be prohibited from use in certain products.

Standard of Identity. The minimum requirements (cut, ingredients, processing, etc.) for meat or poultry food product to be identified or labeled with an established or acceptable name.

Starter Culture. A standardized bacterial culture used in making fermented sausage.

Validation. A process of obtaining evidence to demonstrate that a particular food will be fit for intended purpose, through the achievement of any regulatory limit or operator-defined limit.

Verification. The application of methods, procedures, tests, and other checks to confirm compliance to the documented Food Safety Program and/or regulatory requirements.

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