Partial List of Regulated Substances for Cured Pork and Beef Cuts

Ingredient	Use
Added Water hams	10 percent in cured smoked
Ascorbic Acid or Erythorbic Acid	75.0 oz. to 100 gallon pickle (10 percent pump level)
Sodium Ascorbate or Erythorbate	87.5 oz. to 100 gallon pickle (10 percent pump level)
Phosphates	0.5 percent in finished product
Sodium Nitrate or Potassium Nitrate	3.5 oz. to 100 lbs. meats (dry cure) 7.0 lbs. to 100 gallon pickle
Sodium Nitrite or Potassium Nitrite	1.0 oz. to 100 lbs. meat (dry cure) 2.0 lbs. to 100 gallon pickle (10 percent pump level)

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Meat Curing

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Meat curing is the application of salt, color fixing ingredients, and seasoning in order to impart unique properties to the end product.

Historical Background

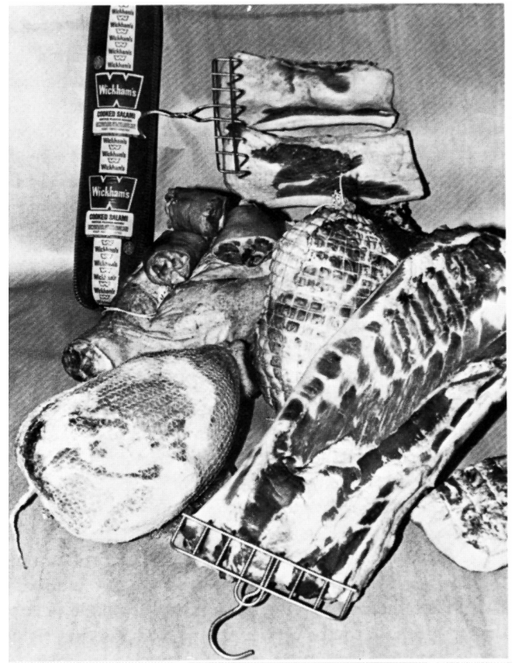
The salting and smoking of meat was an ancient practice even before the birth of Christ. These early processed meat products were prepared for one purpose, their preservation for use at some future time. Salt was used at concentrations high enough to preserve the meat. Preservation by smoking is believed to have been developed inadequately by the primitive tribes. The American Indians preserved meat prior to settlement by Europeans by hanging it in the top of a teepee to maximize contact with campfire smoke.

The origin of the use of nitrite is lost in history. Salt containing nitrates was used in Homer's time (850 B.C.) to preserve meat. Nitrate was present originally as a natural impurity in the salts used in curing but, unknown to the users, was a key ingredient in the curing process. The Romans, who learned the art of curing meat with salt from the Greeks, were the first to note the reddening effect now attributed to nitrite. Although the role of nitrites in cured meat was not really understood until early in the 20th century, it is clear that for thousands of years nitrite has played an important role in meat curing.

Selection and Handling of Meat

Meat is a highly perishable product in which deteriorative changes begin soon after bleeding the animal. The primary cause of product deterioration is microorganisms which may be bacteria, yeasts, or molds. The tissues of the living animal are essentially free of these. However, the first source of contamination is with the sticking knife in the bleeding process. Other sources of contamination are associated with handling conditions such as contact of the hide, puncture of the intestinal tract and improper cleaning of equipment used for cutting and processing. The best way to keep deterioration of product to a minimum is with low cooler temperatures and a good sanitation program. Proper handling of meat is the key to successful meat curing.

Rapid chilling of the hog carcass or any other meat cuts is a must to prevent spoilage. With adequate refrigeration (32-35°F.), it takes 12 to 15 hours to chill a 150-pound hog carcass down to 40°F internal temperature. This is extremely important since warm meat may start spoiling before the salt penetrates to the center of the cut. "Ham Sour" from anaerobic



Cured Meat Products.

bacteria present in lymph nodes or bone joint may result if the fresh (uncured) ham is not chilled below 40°F.

Cuts most commonly cured from pork are the ham, shoulders, and belly, while jowl and loin are sometimes cured. Most commonly cured beef cuts are briskets, strips of round, or chuck and plates which can be cured as beef bacon.

Sanitary conditions can affect the flavor of fresh or cured meats. Thus, it's essential to have clean equipment and facilities to produce the highest quality cured product.

The work area should be cleaned daily with warm water (130°F.) and detergent followed by a sanitizer for microbial control. All complete sanitation programs should include these steps.

Curing Ingredients

The two main ingredients that must be used to cure meat are salt and nitrite. However, other substances can be added to accelerate curing, stabilize color, modify flavor, and reduce shrinkage during processing.

Salt is the primary ingredient used in meat curing. Originally it served as a preservative by dehydration and osmotic pressure which inhibits bacterial growth. Salt still functions as a preservative in the "country style" cured meat product. The main function of salt in other cured products is to add flavor. However; even at low concentrations salt has some preservative action. Salt levels are dependent on consumer's taste, but a two to three percent concentration in the product is about right.

Nitrates and nitrites, either potassium or a sodium salt, are used to develop cured meat color. They impart a bright reddish, pink color, which is desirable in a cured product. In addition to the color role, nitrates and nitrites have a pronounced effect on flavor. Without them a cured ham would be simply a salty pork roast. They further affect flavor by acting as powerful antioxidants. Antioxidants are compounds that prevent the development of oxidative rancidity, which would reduce the keeping quality. Sodium nitrites also prevent the growth of a food poisoning microorganism known as Clostridium botulimum, the bacteria that causes botulism.

Nitrates and nitrites must be used with caution during curing. They are toxic when used in large amounts. The Federal and State Meat Inspection regulations limit the amount that can be used in curing. It is important that exact amounts are used and the curing mixture is thoroughly mixed. The use level of sodium nitrate or potassium nitrate (saltpeter) is 3 $^1/_2$ oz. per 100 pounds meat for dry cure or 7 pounds nitrate per 100 gallons pickle (liquid cure) at 10percent pump level. The use of sodium or potassium nitrite is limited to 1 oz. per 100 pounds meat for dry cure, or 2 pounds per 100 gallons pickle (liquid cure) at 10percent pump level. Nitrites combined with nitrates should not be greater than 156 ppm ingoing into hams or 120 ppm ingoing into bellies.

Sugar (sucrose) serves several important purposes in cured meat. First of all, it adds flavor, and secondly, it counteracts the harshness of salt. Also sugar provides a surface color characteristic of aged ham if caramelized sugar is used. Both brown and white sugars can be used. The sugars most frequently used are sucrose, cane sugar, dextrose, and invert sugar. The amount of sugar used is selflimiting due to its sweetening power.

Ascorbates (sodium ascorbate or sodium erythorbate) are used to speed the curing reaction by faster color development through more rapid reduction of nitrates and nitrites to nitric oxide. The nitric oxide combines with the meat pigment, myoglobin, to form nitrosomyglobin, dark red color. When the product is heated to 130-140°F the nitrosomyoglobin is converted to a stable pigment, nitrosohemochrome light pink in color. Also ascorbates are used to stabilize cure color of meats. The most frequently used cure accelerator compounds are sodium ascorbate or sodium erythorbate. Curing pickle containing these compounds should be used within 24 hours because their reaction with nitrite will lower the nitrite level of the pickle and its effectiveness.

The ingredient phosphate should be used only for those meats cured with a liquid cure. Phosphates are adjuncts used to increase the water holding capacity of cured products. Increased water holding capacity will increase yields of product and improve retention of brine. Phosphates are not easily soluble in a pickle. It is recommended to dissolve the phosphates first then add it to the pickle. Sodium tripolyphosphate, sodium hexametaphosphate, and sodium pyrophosphate are approved by USDA for use in meat curing.

Water must not be taken for granted as an ingredient of curing pickle (liquid cure). It acts as a carrier of the other ingredients, influences composition of the meat, and it may contribute to palatability or juiciness of the product. Yield of finish product is dependent on amount of water retained during the curing and cooking process. Such yields are critical in determining the price of the finished cooked product.

Method of Curing

Curing materials may be in either dry or liquid form. They will be applied either to the surface of meat or into it by some injection method. The oldest method of cure application is dry cure in which the curing ingredients are rubbed on the surface of the meat. The dry, sugar cure method can be used under wider temperature variations and will have less spoilage problems under unfavorable curing conditions. A simple and time-tested dry-curing formula is as follows:

- 8 lbs. salt
- 3 lbs. sugar
- 2 oz. sodium nitrate
- $^1/_2$ oz. sodium nitrite (or a total of 3 oz. nitrate available; remember, excess nitrite is toxic)

Also, a prepackaged cure or modern cure mix can be purchased from a spice or seasoning company.

One ounce of cure mixture per one pound of pork should be used. Hams will require three separate rubbings at three- to five-day intervals. Picnics and butts will require two rubbings at three- to five-day intervals. The belly will require one thorough rubbing with a little sprinkling over the flesh side of each belly. The cure mixture should be divided into two or three portions for the number of rubbings. At the end of the three- or five-day interval another portion of the cure mixture should be rubbed in. When curing, meat should be held in a non-corrosive vat or containers that will drain so the cuts do not rest in their own brine.

The length of curing is seven days per inch of thickness. An example, if a ham weighs 12-14 pounds and is 5 inches thick through the thickest part, this ham should be cured 5 x 7 = 35 days. A belly two-inches thick should cure in 14 days. Another important consideration is to be sure the cure is rubbed into the aitch bone joint and hock end of the ham to avoid bone sour. During curing the product should be stored at temperatures between 32° to 40°F.

If the dry cure mix is dissolved in water, it is called a brine or pickle. The meat can be covered with this pickle and the system is known as immersion curing. Immersion curing is slower and the pickle solution has to be changed every 7 days to prevent spoilage. A sweet pickle cure with a salimeter reading of 75° can be produced by adding 5 gallons of water to the 8-3-3 mixture (above). A salimeter (salometer) should be used to measure the strength (salinity) in the curing brine.

For quality curing and maintaining the same salt level in the finished product, a salimeter is a necessary instrument of the industry. When using the salimeter to determine the salt level of the brine or pickle, be sure salt is the only ingredient in the water. Sugar and phosphates will raise the salimeter readings. Also the temperature of the water will influence the reading, so be sure and check the temperature at which the salimeter is to be used. However, most salimeters are used at 60°F. (Salimeters can be purchased at a meat equipment-supply for approximately $7.)

A useful calculation for determining percent salt in a brine is to multiply the salimeter reading by 26.4 percent. The 26.4percent comes from 100° brine (saturated) equals 26.4percent salt.

The percent salt in 70° brine is:

70 x 26.4percent (0.264) = 18.48percent salt in brine.

The next application is to relate the saltiness of the brine to the saltiness of the pumped meat.

$$\%\text{ salt in finished product} = \frac{\%\text{salt in brine} \times \text{percent pump}}{\text{yield}} \times 100$$

Example 1: 70° brine, pump 15% yield of finish product 102%

$$\%\text{salt in finished product (2.72 \% Salt)} = \frac{.1848\ (\%\ \text{Salt}) \times 15\ (\%\ \text{Salt})}{1.02\ (\%\text{yield of finished product})} \times 100$$

Example 2: 70° brine, pump 15%, yield of finish product 85%.

$$\%\text{ salt in finished product (3.26 \% Salt)} = \frac{.1848\ (\%\ \text{Salt}) \times 15\ (\%\text{Salt})}{.85} \times 100$$

For pumping pickle its usually recommended to use a salimeter reading of 70° to 85°. Then for the cover pickle the pump pickle can be diluted to 55°-65° brine.

Curing time for hams and picnics in brine is 3 $^1/_2$ to 4 days per pound per piece of meat. Another way to figure curing times is to allow 11 days per inch of thickness measuring the greatest thickness through the center of the cut. A 15 pound ham will take 60 days to cure by the immersion cure method.

To speed up curing, the brine or sweet pickle can be pumped or injected into the cut. Injection of the cure is accomplished either by stitch or artery method. The stitch method involves the use of a perforated needle or several needles that distribute the pickle when injected into the meat.

Another type of cure injection used especially for hams, picnics and beef tongues is by the arterial system. This procedure utilizes the naturally occurring vascular network for quicker and complete distribution of the cure. The pickle is pumped by a small gauge needle through the femoral artery of the ham.

Any type of injection curing will speed up the distribution, and the more complete the distribution, the shorter the curing time. The curing time with the injection method may be as short as 24 hours. The pickle solution can be prepared by the procedure previously explained. The pickle can be pumped into the ham at equivalent to 10 percent of its weight (a 15 pound ham requires 1.5 pounds of pickle). When pumping, place the meat on a scale to determine when the proper amount of pickle has been pumped into the meat. During the curing period, the product should be kept at 36 to 40°F.

Smoking

Three traditionally recognized reasons for smoking meat are for preservation, appearance, and flavor. Smoked meat is less likely to spoil than unsmoked meat. Smoking improves the flavor and appearance, aids in reducing mold growth,as well as retards rancid flavors. It takes about 24 hours to smoke and cook hams. Smoking is usually accomplished in three stages. During the first phase, or drying stage, the smokehouse is heated to 125°F. All dampers are opened to allow all excess moisture to escape and there is no smoking during this 8-hour period. During the next eight-hour stage, the dampers are partially closed and the temperature on the house increased to 135°F. and smoke is generated. The smoke is continued throughout the third stage with all dampers closed, and the temperature on the house raised to 180°F. Hold this temperature until the product temperature reaches 142°F. These hams will require further cooking in the home for full tenderization. Hams sold as "fully cooked" have received extra heat processing to an internal temperature of at least 148°F.

The wood used to generate the smoke should be of the hardwood species. Do not use pine or any other resinous wood or sawdust because the smoke from such wood will be sooty and strong smelling. It is recommended to use wood or sawdust from hickory, apple, plum, oak, maple, ash, or any non-resinous wood to obtain satisfactory results.

Summary

Successful curing is dependent on proper handling of meat and using good quality cure ingredients. Curing provides preservation of product, but such cured products still have a short shelf life of 30 days at refrigerated temperatures. Remember to handle with care.

For More Information

Food Products Formulary, Volume 1: Meats, Poultry, Fish, Shellfish, S. L. Komarick, D. K. Tressler and Lucy Long. 1974. Library of Congress, Card Catalog Number 73-94091. Available from AVI Publishing Company, Inc., P. O. Box 831, 250 East Street, Westport, CT 06880. This publication contains several formulas on sausage products.

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