

Some Solutions To Difficulties Of Home-Curing Pork

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I. Introduction

For centuries, meat has been preserved by drying, salting and smoking. Chinese ancestors have used salt to cure and preserve meat since the 13th Century B.C. Preservation by smoking is believed to have been developed inadvertently by primitive tribes who lived in caves and burned fires for warmth and to discourage predatory animals. The American Indian preserved meat prior to settlement by Europeans through hanging it in the top of a tepee to maximize contact with campfire smoke. During the past, meats have been cured to reduce spoilage. These meats were unevenly cured or dried and were frequently salty or too heavily smoked. After the development of refrigeration systems, meat has been cured primarily for the development of color and flavor desired by many consumers.

Curing is the addition of salt, sugar, nitrates, nitrites and sometimes phosphates and ascorbates to meats for preservation, color development, and flavor enhancement. The functions of each ingredient used in curing are:

Salt

- A. Provides a characteristic flavor to impart a cured meat taste.
- B. Acts as a preservative through growth inhibition and destruction of microorganisms.
- C. Enhances the transport of other cure ingredients throughout the muscle by osmotic movement of salt itself.
- D. Dehydrates meat tissue to reduce bacterial growth.

Sugar

- A. Provides a characteristic flavor to impart a cured meat taste.
- B. Counteracts the harshness of salt.
- C. Provides an energy source for microorganisms which

- convert nitrate to nitrite during a long term cure.
- D. Provides a surface color characteristic of aged ham if caramelized sugar is used.

Nitrates and Nitrites

- A. Contribute to the characteristic cured flavor.
- B. Contribute the characteristic reddish-pink color of cured meat.
- C. Prevent growth of a food poisoning microorganism known as *Clostridium botulinum* which can occur in foods that require heat processing.
- D. Retard the development of oxidative rancidity and rancid taste.
- E. Prevent warmed-over flavor in reheated products.

Phosphates

(This ingredient should be used only for those meats cured with a liquid cure known as a pickle.)

- A. Reduce rancidity development and shrinking during curing and smoking of meat by use of a pickle (cure ingredients dissolved in water) that is injected into the muscle tissues.
- B. Reduce cooking loss of the cured product.

Ascorbates

- A. Speed the curing reaction by faster color development through more rapid reduction of nitrates and nitrites to nitrous acid and ultimately nitric oxide that combines with myoglobin (a muscle pigment) to fix the cured color.
- B. Reduce oxidation and subsequent off flavor and color.

A specialized product such as the home cured Virginia ham is considered to be a superb product because of its distinct and unique taste. The purpose of this publication is to discuss potential problems related to home-curing pork and to provide possible solutions to these problems.

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II. Why Dry Cure?

Dry curing was the original method of preserving meat through a dry rub method of cure application. This method, which was brought forward from early civilization to the 21st century, involves mixing the cure adjuncts and subsequently rubbing the mixture on the external surfaces of the meat to be cured. Penetration of cure adjuncts primarily from the lean surfaces occurs via osmosis (created by salt). Therefore, this method involves long periods of storage with one or two additional applications of curing ingredients (a process known as "overhauling"). Although this cure method requires 1-2 months (or longer) for larger pork cuts such as hams and involves a large amount of shrinkage, it is considered a popular method for curing hams in Virginia. In fact, the Virginia Style Cured Ham was one of the first agricultural products exported from North America and continues to be exported every year. The Virginia ham is distinguished as a product with a distinct and unique flavor preferred by many throughout the world. The distinct advantages of a country cured ham by introduction of a dry rub cure are:

- A. Unsurpassed flavor and texture for a speciality product.
- B. Curing may be conducted as an easy operation without elaborate equipment.
- C. Needs for preservation are minimal since bacterial growth is retarded by the salt and the final product is drier than other cured meats.

III. Curing Mechanism

When cure is administered, the salt diffuses inward, to form a complex with the meat proteins. The slower the diffusion inward, the longer the outflow of water and soluble proteins from the muscle. The basic mechanism involved in meat curing involves the action of nitrates and nitrites. Although other reactions and steps are involved in the curing mechanism, the following sequence of events provides a simplified explanation of the process. Nitrate is converted to nitrite by a reducing action of microorganisms that are present within the meat tissues. Reduction of nitrite to nitrous acid and ultimately to nitric oxide is effected either by microorganisms or by the muscle's own enzyme system. Nitric oxide binds to myoglobin, the meat pigment protein, to provide the characteristic cured meat color. This cured color is fixed by application of heat during the smoking process.

IV. Effect Of Curing On The Nutritive Value

The biological value of meat proteins is not lowered by curing and the B-complex vitamins are essentially unaffected. However, minimal losses of water soluble

vitamins can occur through weeping. During storage, cured meats deteriorate through discoloration, oxidative rancidity, and microbial changes. These conditions will be discussed later.

Nitrates up to 3 1/2 oz. per 100 lbs. of meat are permitted in a limited quantity in dry cured meat because of their importance in flavor, color fixation, and retardation of bacterial growth. Since nitrates may be toxic when eaten in large quantities, care should be exercised to use only the recommended amount as supplied in the commercial cure to be used. Commercial cures may be purchased from farm supply stores and some drug and food stores. A frequently used dry cure mixture utilizes 8 pounds of salt, 2 pounds of sugar and 2 ounces of sodium nitrate (dry cure only). These ingredients are mixed thoroughly and frequently divided into three equal parts for application at three intervals.

V. Problems - Solutions Of Home-Cured Pork

Although home curing of pork may be successfully conducted if the proper steps are taken, certain precautions should be taken to improve the finished product. The following problems that are discussed can frequently occur. However, as the discussion suggests, solutions exist to maintain an acceptable product.

- A. Lack of uniformity of size and shape of cured cuts - Uniformity can be improved by selecting cuts or live hogs from a specific weight range. Most hogs are slaughtered when their live weight ranges from 240-270 pounds. This size hog produces uncured hams that weigh 16-20 pounds. Picnics from hogs in this weight range weigh 8-10 pounds and the uncured belly averages 15-18 pounds.

Uniformity of shape of each cut can be provided by separation of all cuts from the same location. An example of correct fabrication procedures of pork cuts to be cured is:

1. Ham fabrication - The ham should be separated from the carcass by cutting through the center of the hock. The ham and loin should be separated between the 2nd and 3rd sacral vertebrae (2nd vertebra from the juncture of the rump and back) and cut perpendicular to the long axis of the shank.
2. Belly fabrication - The belly and shoulder should be separated from the 2nd and 3rd rib from the cranial (front) end. The belly should be removed from the loin along a line adjacent to the tenderloin and ventral (belly side) portion of the blade bone of the loin. The spareribs should be removed from the belly and each end of the belly should be trimmed of excess fat to make it a correctly shaped rectangle.

3. Picnic and Boston butt fabrication - The foot should be separated from the shoulder 1 1/2 inch above the knee joint. The neckbones should be removed by cutting beneath the sternum, ribs, chine bones, and feather bones. The brisket flap should be cut off on the inside of the shoulder and the jowl removed parallel to the breaking line between the 2nd and 3rd ribs. The picnic and the Boston butt are separated by cutting 1/2 inch below the exposed blade bone and at right angles to the breaking line between the 2nd and 3rd ribs.
- B. Trichina infested pork- Improved management among pork producers has been responsible for almost complete elimination of *Trichinella spiralis* infestation in pork in the U.S. during the past few years. To ensure protection against trichina, all pork should be held at 0°F for 14 days or heated to 142°F during smoking and conventional cooking.
- C. Unsanitary pork - To ensure a sanitary product, all animals to be slaughtered should be in a thrifty condition and free of unsound conditions, i.e., abscesses, bruises, etc. Clean facilities and equipment are required to reduce contamination of pork during the slaughter and fabrication process. Proper sanitation prevents contamination by microorganisms that pose a health concern and cause spoilage through discoloration, off-flavor and odor development. Even though sanitary precautions are taken, bacterial growth can still occur. Therefore, pork should be stored as close to 32°F as possible prior to curing. Certain bacteria grow about ten times as fast at 38°F as at 32°F. In addition to protection from spoilage, proper chilling after slaughter will reduce moisture loss and improve pork color and firmness.
- D. Pale, soft and exudative pork (PSE) - Pork that is very light colored and lacks firmness is less desirable for curing. Pale and soft pork experiences more loss of moisture through weeping. This condition, which is responsible for poor cured color development, yields pale colored pork that sometimes has a gray or green tinge after being cured. The soft appearance gives a lower quality appearance and the exudative condition is responsible for more weight loss during curing and makes the pork more difficult to handle due to the moist condition. A soft muscle structure causes more muscle separation and uneven cure penetration. Greater muscle separation may permit more microbial contamination and insect invasion during storage.

The PSE condition can be corrected by slaughtering swine that are rugged, thrifty and with enough finish to have 0.7 inch or more of backfat thickness over the back. Hogs that show evidence of the PSS (porcine stress syndrome) condition are unthrifty and should

not be kept as replacement stock or used for cured pork. The PSE condition can be minimized by proper temperature control from slaughter to curing.

- E. Cure penetration and equalization - To ensure proper cure penetration, the proper cure mixture must be used and the proper application time and method is essential. The cure mixture depends upon personal preference. As previously mentioned, the dry cure mixture that utilizes 8 pounds of salt, 2 pounds of sugar and 2 ounces of sodium nitrate (saltpeter) for 100 pounds of fresh meat is recommended because it yields cured ham characteristics that are preferred by more consumers. Although it has not been proven conclusively, some research results have suggested that nitrate and nitrite are associated with increased cure penetration. The first part of the mixture is rubbed on all surfaces of the meat including the shank end of the hams. A thin layer (1/8 inch) of the cure is applied over all cuts prior to stacking in the curing room, skin side down on a table or shelf. Do not stack more than three high. The other parts of the mixture are added on the fifth and tenth days after the initial application.

The optimal cure time for maximum cure penetration is 7 days per inch of product thickness, or 2 days per pound of product. The preferred temperature during curing is 40°F. This temperature will increase the speed of the cure penetration and reactions and reduce microbial spoilage. In Virginia, the best time to dry cure hams is in late December. Pork cured with too much humidity will not have sufficient cure penetration and the product will have too much moisture as a finished product. Dry cured meats should lose at least 18% of the original weight and most strive for 25 - 30% loss. If the relative humidity during curing and aging is above 80%, forced air movement by a fan or other means should be considered to assist with lowering product moisture content. Forced air from a furnace will also reduce moisture content. After the cure time has expired, the cured cuts should be placed in a tub or large container filled with clean lukewarm water (not exceeding 80°F) for approximately 3 hours to improve quality and appearance. Soaking will dissolve most of the surface curing mix, distribute the seasoning more evenly, draw out some of the heavy salt concentration on the surface and make the product more receptive to smoke. After soaking, the product should be scrubbed with a stiff bristled brush and allowed to dry for about 3 hours before smoking. These practices will improve cure penetration and reduce the salty taste from dry cured pork.

- F. Improper smoking - Most cured pork products are smoked to improve flavor, color and preservation.

Careful attention should be given to this operation to prevent microbial spoilage and insect infestation. Insect infestation will be discussed later. Cuts to be smoked should be placed in a smokehouse* with adequate space between each other and the walls to permit smoke circulation and penetration. Tight construction and properly fitted ventilators provide effective regulation of the air flow. An outside firebox makes temperature control easier and reduces the hazard of fire.

The combustible material used to generate smoke is important to smoked flavor development. Smoke from the sawdust or chips of hardwoods should be used, since the burning of softwoods results in a sooty deposit on smoked meats and is responsible for a bitter flavor. Hickory is the most popular wood for smoking, but maple, apple, cherry, plum, peach, oak and ash may be successfully used. Cedar, pine, spruce and other "needle leaf" softwoods give off resins, which are responsible for the bitter taste and odor, and should not be used.

The absorption of smoke and the change in color of the outside surface of smoked meat is increased by higher temperatures. A "cool" smoldering type of smoke is commonly used by firms that dry cure in Southern Virginia. The "cool" smoke should be generated in a smokehouse with a temperature below 90°F. This smoke process is utilized until the meat turns chestnut brown in color, which may require 3-10 days.

- G. Incomplete color development - The rate of the cured color development is proportional to the concentration of nitrite up to the point where the nitrite: color pigment (metmyoglobin) ratio is 5:1. Beyond this point nitrite appears to inhibit cured color development. Therefore, incomplete color development can result from too much of this cure ingredient (or nitrate) being applied. Various contaminating microorganisms can impair color development. Other deleterious effects of these microorganisms include souring and putrefaction. Therefore, control of microbes by proper sanitation and temperature control is imperative.
- H. Improper aging - The aging period is critical for dry cured pork since it is during this time that the distinguished honey-cured flavor is developed. Aging time is required to develop the flavor typical of home cured pork as is time for aging of beef, cheese and wine. Home cured pork cuts should be aged for 5 months and can be aged up to a year or longer. During aging, cured meats should be covered with heavy paper bags (without rips or tears) to provide a barrier

between the meat and insects. (More information is available in VCE Publication 458-223, Curing Ham Virginia Style.)

- I. Color fading during storage - Although the smoking process helps fix the cured color, it is still rather unstable. The cured color will fade due to oxidation under UV radiation and in the presence of oxygen. Thus, cured meats should be exposed to minimal lighting since most lighting contains some UV rays. Restriction of air by vacuum packaging or by use of other wrapping materials impermeable to oxygen will reduce color pigment fading.
- J. Rancid flavor - A rancid taste is frequently associated with home-cured pork. Many people prefer cured meats with a ripe, rancid flavor that results from adding salt to the cure formula and long term aging. Salt increases oxidation which causes a rancid flavor. Salt accelerates the action of an enzyme present in muscle called lipoxidase. Smoking reduces the activity of this enzyme but ascorbic acid, which is sometimes used in liquid cures, increases the activity of lipoxidase.

Since a rancid flavor is typical of home-cured pork, it is considered a trait associated with this curing method. If a rancid flavor is not liked, a shorter curing and aging period should be considered. Rancidity among home cured cuts can be minimized by reducing the aging period and by not freezing the cured product. Extended storage of frozen cured meats enhances oxidative rancidity. Under certain conditions, a change in certain fat components (i.e., fat reversion) will cause a change in flavor.

Wrapping material that does not properly protect the cured product will contribute to dehydration and additional oxidative rancidity. If cured meats are to be frozen, the best grade of freezer wrapping paper available should be used to wrap the product. The "drugstore" wrap is a possible way to protect cured meat, but other methods that do not trap the air inside the finished package are satisfactory. After the edges are sealed to prohibit air entry, a label and date should be applied on each package prior to freezing at -10°F or colder. Proper protection during freezing will ensure less dehydration or development of oxidative rancidity.

- K. Souring, putrefaction and tainting - Souring and putrefaction are caused by contamination by microorganisms. Contamination can occur at several steps of the process, but usually takes place between slaughter and curing. Microbial contamination is increased by improper sanitation and storage of the

*Plans for a small smokehouse can be obtained from Department of Food Science and Technology, Virginia Tech, Blacksburg, Virginia 24061.

fresh product for too long (over 5 days) at a temperature too high (over 32°F). Microbial spoilage can also be increased by using cure ingredients that are contaminated and by unsanitary conditions in the cure area, smokehouse or aging area. Improper packaging of the finished product will also increase contamination and subsequent growth of bacteria responsible for discoloration and flavor deterioration.

Tainting will frequently occur among dry cured meats. This condition is caused by greater difficulty of cure penetration into the muscle tissue and by pork with a pH that is above normal. The higher pH stimulates bacterial growth which causes the tainted condition. This condition is normally less common if time between slaughter and cure is reduced.

L. Mold growth - As with aged cheese, mold growth is common among cured meats that are aged. Molds may be removed with a mixture of 10% acetic acid and 90% water or other equivalent rinses. After the mold is trimmed or removed by scrubbing and rinsing, the product is satisfactory for consumption.

Molds are common in the air and will thrive if proper temperature and moisture conditions (as during curing and aging) exist. An effective way to prevent molds on cured and smoked meats is to store them in a dry, well ventilated room with a temperature range of 45 - 55°F and a relative humidity of less than 68%. Unwrapped meat should not touch other meat. This method of holding increases dehydration, but weight loss is less expensive than loss from trimming mold.

M. Salty taste - As previously suggested, home-cured pork has a characteristic salty taste. Saltiness can be reduced by soaking cured cuts prior to smoking or prior to storage if smoking is not done. Increased effectiveness from soaking is possible through changing the water at least once during the process and by increasing the soak time up to 24 hours. If the cured meats are still too salty, frying in a skillet that contains about 1/4 inch of water will dilute the salt concentration and result in a less salty product.

N. Insect infestation - Since meat is a good source of food for insects, cured-meats are commonly attacked by insects during storage. Insects that most commonly infest home-cured meat are the cheese skipper, the larder beetle, the red-legged ham beetle, and mites. Generally, cured meats should be placed inside one or two paper bags free of rips and tears with the top tightly tied. Wrapped cuts should be stored in a dry, cool room that has been protected against insects. Specific characteristics of these insects include (Figure1):

1. Cheese Skipper—This insect gets its name from the jumping habit of the larvae which bore through cheese and cured meats. Meat infested with this insect quickly rots and becomes slimy. Adult flies are two-winged and are one-third the size of houseflies. They lay their eggs on meat and cheese and multiply rapidly.
2. Larder Beetle—This insect is dark brown and has a yellowish band across its back. The adult is about

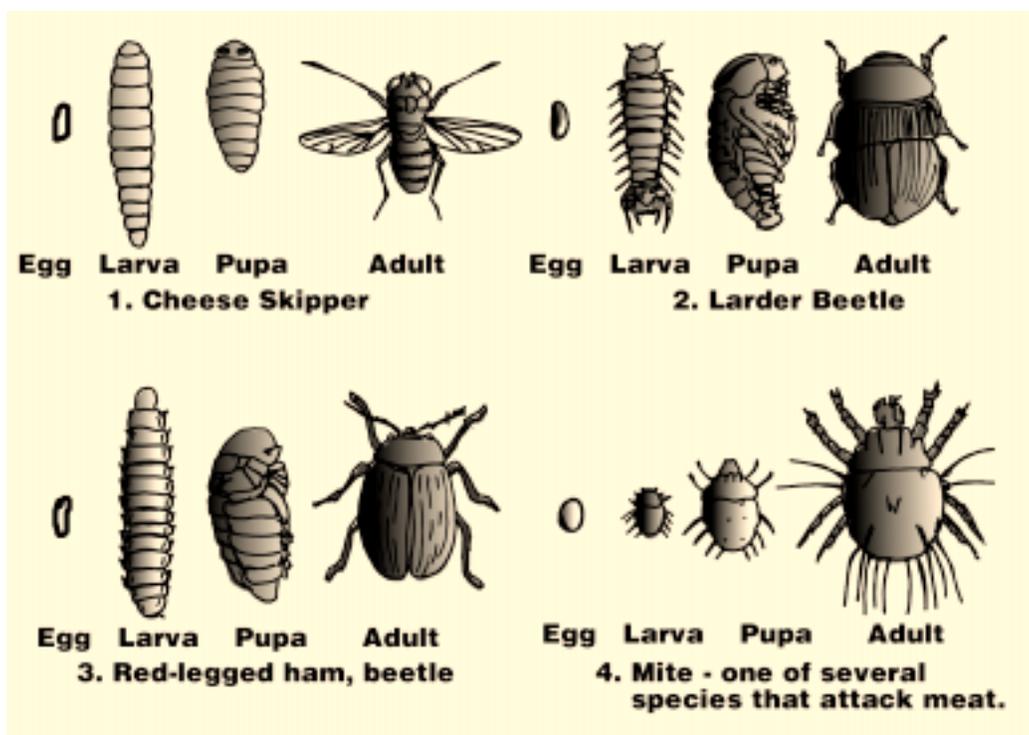


Figure 1. revised from Home and Garden Bulletin No. 109, U. S. Dept. of Agriculture, Washington, D.C.

1/3 inch long. Its larva feed on or immediately beneath the cured meat surface, but do not rot the meat. The larvae are fuzzy, brownish, and about 1/3 inch long at maturity.

3. Red-Legged Ham Beetle—The larvae are purplish and about 1/3 inch long. They bore through the meat and cause it to dry rot. Adults are about 1/4 inch long, brilliant greenish blue with red leg, and are red at the bases of their antennae. They feed on the meat surface,
4. Mites—Mites are whitish and about 1/32 inch long at maturity. Affected parts of meat infested with mites become powdery.

Recommended precautions include pork slaughter and curing hams during cold weather when these insects are inactive. Proper cleaning of the aging and storage areas is essential since the cheese skipper feeds and breeds on grease and tiny scraps of meat lodged in cracks. (Cracks should be sealed with putty or plastic wood after cleaning. Screens should be installed to prevent entrance - especially of flies, ants and other insects that carry mites.) Double entry doors are recommended to reduce infestation of insects.

After cleaning and sealing cracks, a surface spray should be applied to the floor so that the thin layer of insecticide will kill insects that crawl over the deposit. Spray aging rooms once every three months with a pyrethrin-based spray to reduce infestation. Follow mixing and application directions on the pesticide label. This insecticide may be applied with a paint brush if the room is stocked with meat. If applied as a spray, remove all meat products from the storeroom before spraying. Allow the spray to dry before any meat is returned to the store room.

If any product becomes infested after precautions have been taken, it should be removed from the storeroom and the infested area should be trimmed. The trim should be deep enough to remove larvae that have penetrated along the bone and through the fat. The uninfested portion is safe to eat, but should be prepared and consumed promptly. The exposed lean of the trimmed areas should be protected by greasing it with salad oil or melted fat to delay molding or drying. Ham trimmings can be used as seasoning or incorporated in ham sausage.