Lesson 7: Processing Meat Animals

By the beginning of the 20th century, meat packing was the nation's largest industry. Its one billion dollar annual sales exceeded the total yearly budget of the U.S. government! The refrigerated railroad car had quickly changed the focus of livestock producers from producing animals excelling in stamina to animals bred for carcass quality. By 1880, the U.S. was exporting beef to England, which had long claimed to have the world's best beef. Gustavus Swift, a meat packer from Chicago, established the first refrigerated railroad car service. Soon to follow was Philip Armour, another Chicago meat packer. These men helped convert meat processing into a mechanized industry. Chicago had the reputation as the hog butchering capital of the world.

Steps in Processing Meat Animals

Modern processing techniques are quite different than those used in the early 1900s, yet the multi-step agenda remains. Depending on the meat species being processed, the steps may vary.

Immobilization is the first step in processing a meat animal. Usually the animal is stunned with either a rod (mechanical), CO_2 (chemical), or an electrode (electrical). Once the animal is stunned, it is stuck with a sharp knife, severing its carotid arteries and jugular vein. A good stick can remove up to 50 percent of the animal's total blood. The process is called exsanguination. It is important to bleed all meat animals thoroughly and quickly. Immediately following death, the heart continues to pump and will do a thorough job of removing the blood.

The Kosher method of exsanguination is performed by a rabbi or shohet. The animal is restrained without stunning it and cut across the throat in a single stroke. This process requires much skill. It is considered by some religious groups to be more humane than the more commonly used stunning procedures.

Rigor mortis (stiff death in Latin) is an essential process in the conversion of live muscle to meat. After death, the biochemistry of muscle tissue changes. The muscle will use up energy (from glycogen - a complex carbohydrate found in animal tissue). However, since the blood is no longer flowing to remove the by-products of metabolism, lactic acid builds up in the muscle. This reduces the pH, causing a complex series of reactions that results in the contraction of the muscle fibers. This contraction makes the muscle feel hard or stiff, thus the name rigor mortis.

After more time, the muscle fibers will begin to relax. The relaxation of muscle post-rigor is sometimes called the resolution of rigor. This process is greatly influenced by temperature, being faster at higher temperatures. If you read murder mysteries, you may have noticed the coroner using body temperature and the state of rigor to help fix

the victim's time of death. In processing meats, the time and temperature during rigor are carefully controlled to maximize tenderness. This part of the process is sometimes called aging. In France, the aging process is manipulated to achieve maximum tenderness. The meat becomes almost spoiled by U.S. standards. This process is known as mortification and produces highly prized (and very expensive) meat products.

Beef cattle are immobilized. Immobilization may be by an electrical jolt, which speeds the rigor mortis process and tenderizes the meat. Rodding the weasand is the next step. This procedure separates the esophagus from the trachea and allows the abdominal cavity organs to be pulled out separately from the thoracic cavity organs. Removing the head and neck hide, or heading, is the next step. This precedes shanking, or removal of the foreshanks and rear shanks. Siding, or skinning, follows shanking. Finally, evisceration, or removal of the abdominal and thoracic viscera, precedes splitting the carcass into halves. The carcass is now ready for refrigeration, inspection, and grading.

Hogs are immobilized, stunned and stuck, and then scaled or skinned. Scalding in 141°F-145°F water permits removal of the hair. Heating at this temperature causes the protein in the hair follicles to denature, thus loosening the hair. Removal of hair and scurf (the pigmented epidermal layer) follows. "Polishers" are mechanical devices used to remove the hair in a scraping fashion. The toenails are removed along with the skin and hair on all four feet. If the hog's head is to be used for human consumption, its inner ears must be removed. This eliminates dirt and wax. The head is removed, followed by evisceration, splitting, inspection, refrigeration, and grading.

Following immobilization, stunning, and exsanguination, lambs are pelted (skinned). It is during pelting that lamb carcasses are differentiated from mutton. The front foot is removed at the "break joint", or at the swelling at the lower part of the lamb's cannon bone. In sheep older than about 15 months, this joint is ossified, and the foot is removed at a slightly lower point called the spool joint. After pelting, the head is removed. The esophagus and trachea are separated just before evisceration. The carcass is then ready for refrigeration, inspection, and grading.

Chickens and turkeys are immobilized and stuck to remove the blood. Following bleeding, birds are defeathered. If they are scalded, the carcass is dipped into 150°F-160°F water for only a short period to avoid cooking the skin. The hot water denatures proteins of the feather follicles; this loosens the feathers. If the bird is to be dry-picked, a knife blade must be inserted into the cleft in the roof of the mouth and forced through to the rear lobe of the brain. This process relaxes the feather muscles. This relaxed condition only lasts for 2-3 minutes before rigor mortis begins so feathers must be removed quickly in this process. Following defeathering, the carcass is chilled to 32°F-36°F. The final steps are evisceration and grading.

Most fresh water fish have their heads removed behind their gills. Then, the scales and the tail fin are removed. The entrails are removed by cutting from the anus to the headless area. The body cavity should be thoroughly rinsed and the product chilled.

Processing Fresh Meat Products

Following the slaughtering process, most carcasses undergo further processing before they reach the consumer. The first technique used is carcass size reduction. Beef carcasses are split in half then quartered between the 12th and 13th ribs. Approximately 52 percent of a beef carcass, by weight, is in the forequarters with the balance in the rear quarters. Veal is processed into fore and rear saddles or halves. Almost all of today's beef is sold as boxed. Pork carcasses generally undergo processing to subprimal cuts prior to leaving the slaughtering facility. Lambs, in contrast, are usually shipped whole. Poultry carcasses are shipped either whole or pre-cut. Shellfish are usually shipped whole while fish may be shipped whole or portioned (fillets).

Following carcass size reduction, fabrication of the primal cuts takes place. Examples would be the removal of the relatively low value vertebrae from the whole rib or possibly deboning the entire rib primal cut. Subprimal fabrication is the third step. Here primal cuts are transformed into roasts, steaks/chops, and ground meat. Steaks are generally portions of muscle cut 3/4"-1" thick. Roasts are cut with a thickness of at least 2". Ground meat is free of bones, cartilage, and other heavy connective tissue. Ground meat must be 70 percent lean. Some primal and subprimal cuts undergo deboning, for example, a boneless chuck roast or a fish fillet. Patty production is conversion of boneless meat into uniform, ready to cook patties. Another processing technique involves shelf-life extension. Methods include freezing, heat pasteurization, heat sterilization, curing and smoking, dehydration, irradiation, and, the most popular method, refrigeration.

Tenderization, or improving the meat's tenderness, can be accomplished with either mechanical or enzymatic methods. Mechanical tenderizers pass a bank of needles through the muscle to sever connective tissue and muscle fibers. Enzymatic tenderization uses tropical plant (e.g., papaya, pineapple, fig) enzymes to degrade connective tissue.

Control of composition by restructuring is another processing technique used in the food industry. Restructured meats are those that have been ground, flaked, or chopped and formed into steak/chop or roast-like products. Through restructuring, the percent lean, water content, etc., can be carefully controlled.

Finally, portion control or product sizing is a processing technique used for fresh meat products.

Meat Quality Factors

Various factors affect meat quality. Factors can be production-related, be inherited, or occur during processing.

Production-related factors include: age of animal, health and nutrition of the live animal, and how it is sorted and hauled. As animals get older, their muscles have walked many miles and carried heavy loads, thus reducing their tenderness when consumed. Young animals are, therefore, more desirable in terms of meat tenderness.

Obviously, it takes a healthy animal to produce a healthy carcass. When animals are sick, their bodies draw energy, chiefly fat, from their muscles. The influence of diet on the physical properties of muscle is of minor importance, so long as there are no serious nutritional deficiencies.

Sorting and hauling can have substantial effects on a meat animal. If improperly done, bruising and/or stress may result. Stress on an animal just prior to slaughter can have a dramatic effect on carcass quality. Stressed animals have higher temperatures, lower muscle pH levels due to lactic acid build-up, and early onset of rigor mortis. This can cause muscle tissue to be pale in color, soft in texture, and excessively wet. This condition is called pale, soft, and exudative (PSE). Animals that have survived a stressful period but have not had sufficient time to recover may have dark meat. This is because of a glycogen deficiency in the muscle tissue. As stress increases, lactic acid increases and pH values decrease.

Research indicates that the physical properties of muscle are at least moderately heritable. In beef cattle, heredity is likely to influence tenderness by 60 percent color and firmness by only 30 percent. Heredity influences tenderness by 30 percent, marbling by 25 percent and color and firmness by 30 percent in swine.

Processing-related factors include: sanitation of the processing plant, efficient immobilization and exsanguination, postmortem temperature, postmortem handling, processing sanitation, water holding capacity, and color control.

Certainly, to avoid contamination, consumers expect processing plants to have sufficient sanitation practices. These include proper cleaning/disinfecting of equipment or personnel, absence of cross contamination between offal and carcass, absence of rodents, etc.

Efficient immobilization and exsanguination are important to avoid unnecessary stress. Immobilization should be followed immediately by rapid bleeding to prevent the animal from regaining consciousness and to allow the heart to aid in the bleeding process.

Low postmortem temperatures inhibit microbial growth. Postmortem handling, specifically carcass suspension and prerigor processing, can affect carcass quality. If a carcass is suspended by the achilles tendon, the psoas (tenderloin muscle) is placed under a maximum amount of tension. Consequently, it is extremely tender when compared to muscles allowed to shorten freely during rigor mortis. When a carcass is suspended from the pelvis, the tension is increased in round and loin muscles making them more tender.

The interval of time between slaughter and meat grinding can affect physical properties of the finished product. To maximize the juiciness and water binding properties of sausage, the meat should be ground before onset of rigor mortis. To ensure a moist cut of meat and a higher water holding capacity, surface area must be properly covered and/or packaged. Processors desire to retain the brightest meat color to meet consumer expectations. Whenever meat tissue lacks oxygen contact, like the portion permitted to remain in contact with the surface of a pan, it discolors to a dark red. Meat cutters must ensure proper oxygen contact with meat. They must also be careful to ensure that improper lighting or over-exposure to oxygen does not occur because these, too, can discolor the meat.

Meat Industry

The meat industry represents producers, packers, processors, retailers, and food service operators. In a vertically integrated industry, the packers not only process the meat animals but they also raise the animals and often mill the feed they eat. Whereas with an independent structure, the packer purchases the meat animals from the producer.

The poultry industry in the United States is almost totally vertically integrated. The company that owns the processing plant owns the birds and may also own the feed company. Producers contract with large companies to produce the chickens, while the companies supply the chicks and feed. The producer usually provides the housing, utilities, and the labor. Often the contract producer receives a graduated fee plus a bonus that reflects bird performance and management skills.

Only about five percent of the pork industry is vertically integrated. Usually, lamb and beef processors are independent from producers.

The National Live Stock and Meat Board represents beef, pork, and lamb producers, packers, processors, and retailers. The National Broiler Council and the National Turkey Federation represent the poultry industry in terms of research, education, and promotion.

Summary

The United States has a rich history in meat packing, dating back to the late 19th century. Meat processing, then and now, is a multi-step process beginning with immobilization and exsanguination. Skinning, evisceration, and cutting are processing techniques used on meat animals. Most of today's beef and pork are processed into primal cuts and placed in a box for transport. Further carcass processing/ fabrication is done to prepare the meat for the consumer. Meat may be tenderized or restructured to improve its retail quality. The quality of meat depends on several production-related factors as well as heritability and processing factors. Today's meat industry is very diverse ranging from complete integration to independent producers and processors.

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