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Technical Topics

The Color of Meat

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Color is the primary factor influencing the fresh meat purchasing decisions of consumers. Consumers relate meat color to freshness. Because of that, the meat industry is very cognizant of conditions that can adversely affect color.

The ideal color for a fresh meat cut is species dependent. Consumers expect beef to be a bright, cherry-red color, pork a reddish-pink color, and lamb a pinkish-red color. Muscle fibers contain varying amounts of myoglobin, the main muscle protein responsible for color, with beef muscles containing higher concentrations than pork muscles. Myoglobin concentrations increase with an animals age; thus, the lean from older animals tends to be darker in appearance.

The oxidative state of myoglobin dictates the expressed color of fresh meat. There are three states of myoglobin: oxymyoglobin, deoxymyoglobin, and metmyoglobin. As the name implies, oxymyoglobin is myoglobin bound to an oxygen; it is the predominant form of myoglobin in normal, brightly colored meat. Deoxymyoglobin, myoglobin that is bound to water (or with oxygen removed), has a purplish color, and is commonly seen in vacumm-packaged meat. Deoxymyoglobin readily converts to oxymyoglobin in the presence of oxygen. Metmyoglobin, the brownish color of discolored meats, results from the oxidation of the iron portion of myoglobin.

Metmyoglobin formation in meat in retail cases is a result of prolonged exposure to ultraviolet light from fluorescent lights, temperature fluctuations in retail cases, and bacterial growth. All of the aforementioned result in free radical formation and concomitant oxidation of the iron portion of myoglobin. Individual muscles will accumulate metmyoglobin, thus discolor, at different rates. It is not unusual for meat cuts with multiple muscles groups to discolor unevenly.

Muscle fibers have a natural enzyme system (metmyoglobin reductase) that converts metmyoglobin to deoxymyoglobin which can be oxygenated into oxymyoglobin. There are differences in metmyoglobin reductase activity between individual muscles, however, the extent of its post-mortem activity is a subject of debate. The use of antioxidants, such as feeding Vitamin E, can extend the time to discoloration by sequestering free-radicals.

Some meat cuts do not have discoloration but rather an irregular color than what is typically associated with cuts from that species. Most color irregularities are related to the water-holding properties of the muscle. Stress conditions are typically responsible for irregular colors in muscle. Long-term stress to animals prior to slaughter results in a reduced post-mortem pH decline and consequently a higher final pH. High pH muscle, such as dark cutting beef or dark, firm, and dry (DFD) pork, tends to have a darker appearance because it retains more water resulting in less light reflectance from the surface and less myoglobin in the oxygenated state. Short-term stress, immediately prior to slaughter, results in an accelerated post-mortem pH decline and consequently denaturation of some muscle proteins. Denatured proteins cannot bind water effectively resulting in the loss of cellular contents including myoglobin. Traditionally, this condition is associated with pale, soft, and exudative (PSE) pork.

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