SERVICE IN ACTION

COLORADO STATE UNIVERSITY EXTENSION SERVICE

Effects of pre-slaughter stress on beef and pork carcass characteristics

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Quick Facts

- Pre-slaughter stress of hogs and cattle can result in the production of meat and meat products that are abnormal in muscle color and water retention capacity.
- Consumers discriminate against meat products from stressed animals because their muscle characteristics are different from those generally associated with desirable fresh meat.
- The adverse economic impact of pre-slaughter stress is reflected not only at the retail level, but at the packer and producer levels as well.
- Dark cutting beef is caused directly by long-term, pre-slaughter stress to cattle.
- Conditions that predispose cattle to the production of dark cutting carcasses are exhaustion, sickness, abrupt weather changes, exposure, feed restriction or sudden withdrawal, and pre-slaughter excitement.
- Approximately 18 to 20 percent of hogs slaughtered in the United States are subjected to short-term, pre-slaughter stress resulting in carcasses with pale, soft, exudative (PSE) lean.
- Common causes of PSE pork include high ambient temperatures, various forms of physical and psychological trauma and failure to chill the carcass immediately following slaughter.
- Animals that have been subjected to stress should be allowed a rest period prior to slaughter so muscle energy supplies can return to normal.

Pre-slaughter stress of hogs and cattle can result in the production of meat and meat products that are abnormal in muscle color and water retention capacity. Carcasses produced by animals subjected to long-term, pre-slaughter stress are characterized by lean that is firm, dry and dark red to dark purple in color. In contrast, carcasses produced by animals that are stressed for short periods of time, immediately prior to slaughter, have lean that is soft, watery and light pink to very pale grayish-pink.

Consumer surveys indicate that muscle color and appearance are major criteria used to select fresh meat from the retail case. Correspondingly, consumers discriminate against meat products from stressed animals because their muscle characteristics are different from those generally associated with desirable fresh meat. The muscle color resulting from long-term stress often is confused with the dark muscle color caused by advanced animal maturity or product deterioration, while pale, soft and watery meat, caused by short-term stress, is not only unattractive to most consumers, but also loses considerable moisture during cooking and, consequently, yields a very dry, unpalatable cooked product.

Although reduced consumer acceptability directly affects retail meat prices, the adverse economic impact of pre-slaughter stress is reflected at both the packer and producer levels as well. It is estimated that pre-slaughter stress reduces live value by as much as $2 to $5 per hundred weight (cwt.) for cattle and $6 to $8 per cwt. for hogs.

Dark Cutting Beef

Characteristics. Of the cattle slaughtered in the United States, 2 to 4 percent are affected by pre-slaughter stress and produce dark cutting beef carcasses. The dark color of the lean associated with dark cutting beef is present in varying degrees from that which is barely evident to so-called "black cutters" in which the lean is nearly black in color.

Dark cutting beef has a high ultimate muscle pH (6.3 to 6.8) and, therefore, a high water holding capacity. As a result the muscle fibers are densely packed together and little water is released from the lean surfaces. In addition, the densely packed surface structure of the lean reduces light reflectance and provides a barrier to oxygen diffusion, which prevents formation of the characteristic bright cherry red color of fresh beef (Table 1). These combined effects result in beef cuts with dark red to purplish-black lean colors and firm, dry, sticky lean surfaces.

Evidence does not indicate that the dark cutting condition has any adverse effect on palatability; however, decreased consumer acceptability reduces the economic value of dark cutting beef. In order to reflect the lower market value of dark cutting carcasses, the dark cutting condition is considered in U.S.D.A. quality grading. Depending on the severity of the condition, the final quality grade of a dark curring beef carcass may be reduced as much as one full grade.

Causes. Dark cutting beef is caused directly by long-term, pre-slaughter stress. If the pre-slaughter conditions cause excitability or create excess demand on the animal's body and deplete the energy stores in

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the animal's muscle tissue several hours prior to slaughter, the dark cutting condition will likely result.

Conditions that predispose cattle to the production of dark cutting carcasses are exhaustion; sickness; abrupt weather changes; exposure to cold, wet, windy weather; feed restriction or sudden withdrawal from high energy feeds; and pre-slaughter excitement following an extended haul.

Cattle differ in their ability to withstand stress and in their susceptibility to the dark cutting condition. Higher incidences of dark cutting carcasses are normally observed among bulls and bullocks, heifers in estrus, slaughter calves, forage-finished cattle and cattle that are unusually susceptible to stress. Grain-fed cattle with a moderate degree of finish tend to produce fewer dark cutting carcasses.

Pale, Soft and Exudative Pork

Characteristics. In the United States, approximately 18 to 20 percent of the hogs slaughtered are subjected to short-term, pre-slaughter stress and produce carcasses with pale, soft and exudative (PSE) lean. The adverse economic impact of this condition results not only from reduced consumer acceptability, but also from substantial losses of weight due to moisture loss during cutting, processing and cooking.

In contrast to dark cutting beef, PSE pork has a low ultimate muscle pH (5.2 to 5.4) and a resultant low water holding capacity. Consequently, the muscle fibers are loosely organized and a considerable amount of free water accumulates on the lean surfaces. The loosely organized structure of the muscle surfaces allows for greater scattering of incident light that contributes to the light muscle color. As a result the lean is soft, watery and light pink to very pale grayish-pink.

Causes. Short-term stress, immediately prior to slaughter, causing extensive, premature depletion of the energy stores in the animal's muscle tissue with a concomitant reduction in muscle pH to an abnormally low level while the carcass temperature is still relatively high, results in the PSE condition. Common causes of PSE pork include high ambient temperatures, various forms of physical and psychological trauma and failure to chill the carcass immediately following slaughter.

The majority of PSE pork carcasses are produced by pigs that are particularly susceptible to pre-slaughter stress. In general, stress susceptible swine exhibit porcine stress syndrome (PSS), which is usually characterized by extreme muscularity, nervousness or hyperactivity, muscle tremors and reddening of the skin. In addition, stress-prone hogs produce carcasses with unusually high temperatures and extremely rapid rates of glycolysis (pH drop) that predispose them to the production of PSE lean. PSS is a heritable trait and its incidence can be reduced through controlled breeding and selection. (For more information on porcine stress syndrome, see Service in Action sheet 1.212.)

Guidelines for Prevention of Pre-slaughter Stress

- Ship only on cool days; provide protection for animals from cold, wind, rain or snow during transit.
- Reduce feed 12 hours prior to shipping to increase lung capacity.
- Allow rest period between penning, sorting and loading.
- Avoid excitement during loading, transit and holding for slaughter.
- Avoid overcrowding of animals.
- Avoid mixing of animals of different sizes and swine from various sources.
- Minimize transit time.
- Avoid the use of electrical prods or whips.
- Allow for recovery period after unloading and prior to slaughter; provide feed after an extended haul.

To prevent extremes in muscle color and water holding capacity of lean from animals that have been subjected to stress, a rest period should be allowed prior to slaughter so muscle energy supplies can return to normal. Animals exposed to long-term stress of up to one day, should have up to five days of rest before slaughter. Animals subjected to a few hours of stress, short-term stress, need a 24-hour rest period.

When these guidelines are followed, the incidence of dark cutting beef and PSE pork can be decreased and the large annual economic loss to the livestock industry can be reduced.

Table 1: Comparison of muscle characteristics.

Muscle condition	Color	Light absorption	Light reflection	Fiber structure (firmness)	Water holding capacity	Oxygen penetration into the surface
Normal	bright cherry red (beef) or bright grayish-pink (pork)	medium degree	medium degree	medium compaction (moderate)	some water released	moderate
PSE pork	very pale grayish-pink	small degree	high degree	very open (soft)	medium amount of water released	moderate
Dark-cutting beef	dark red	large degree	very small degree	densely compacted (very firm)	little water released	shallow