

Project Title:	Evaluation of the Relationship between Stress Response and Muscle Tenderness in Feedlot Cattle
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Background

Muscle tenderness is a primary factor determining customer satisfaction of beef products. Consumers readily discriminate between tenderness differences and are willing to pay premiums for beef known to be tender. Despite significant advancements in the current knowledge of factors affecting beef tenderness, the incidence of tough beef continues to be a problem for the beef industry. The characterization of animals that produce tough meat would allow for the development of management strategies to reduce unpleasant eating experiences for consumers.

The activation of the hypothalamic-pituitary-adrenal (HPA) axis in response to stimuli is an important survival mechanism that allows living organisms to maintain homeostasis. The activation of the HPA axis alters the metabolism of carbohydrates, proteins and lipids to make energy available for the animal. This is the basis for the “fight or flight” response observed when animals encounter a stressor. Negative aspects of this response are reduced growth performance and immune response. Additionally, antemortem stressors have been linked to meat quality defects such as dark, firm and dry, as well as pale, soft and exudative lean conditions. These defects are attributed to abnormal muscle pH decline caused by stress-induced glycolytic metabolism. It seems likely that repeated activation of the HPA axis during growth would have negative consequences on meat quality independent of pH.

This project was designed to test whether repeated activation of the HPA axis in animals with excitable temperaments would result in beef that was less tender than beef from calmer animals that were less stress responsive.

Methodology

Steers (144) were selected to evaluate the relationship between animal temperament and stress responsiveness to feedlot performance, carcass merit and meat quality. These animals were obtained from research herds that had previously been used in temperament and stress responsiveness experiments. The cattle differed in biological type and were subjected to management protocols before being included in this study that varied substantially. Due to concerns that these preexisting factors might confound the results of the present study, the researchers segregated the cattle into three trials for the purpose of this research.

The cattle evaluated in Trial 1 consisted of two groups of yearling steers (31 Bonsmara-sired steers and Angus-sired steers) and were fed in two groups. Trial 2 included Angus-sired steer calves (48). Trial 3 used yearling full-blood Brahman (16) steers. The cattle were managed at two different feedlots during the course of the trial.

Measures of disposition and stress response were obtained when the cattle were weighed before shipment, upon arrival at the feedlot, at approximately 70 days on feed and prior to

transport to the processing facility. At the feedlot, the cattle were implanted, vaccinated and placed on feed according to the standard practices of the feedlot facility.

In all groups, the disposition of the animals was evaluated by measuring exit velocity from the working chute. A pair of infrared eyes connected to an electronic timing unit (Farm Tec Inc., North Wylie, TX) was placed approximately one meter in front of the working chute. As the animal passed between the eyes, the timer was started. The timer was stopped as the animal crossed a second set of infrared eyes. Exit velocity was reported in meters per second.

Temperament evaluations were also made during the preshipment data collection sessions and subjective behavior scores were assigned to each animal. Evaluations were made as animals stood in the weigh box prior to being moved into the squeeze chute and also while they were in the holding pens. Blood samples were also collected each time the animals were handled and were assayed for cortisol as an indicator of stress levels.

The cattle were fed to a target endpoint and harvested. All of the carcasses were subjected to a high voltage electrical stimulation immediately before evisceration. Forty-eight hours postmortem carcass merit measurements were taken. Antemortem stress is likely to affect postmortem muscle metabolism. As a result, muscle pH and temperature were recorded at 0.5, four, seven, 12, 24 and 48 hours postmortem. Due to equipment failure, pH data were not measured on the cattle in Trial 2 after 12 hours postmortem. At 48 hours postmortem, the carcasses were evaluated for USDA yield and quality grade factors. Objective L*, a*, b* color measurements were also measured.

Beef loin, strip loins (IMPS/NAMP 180) were fabricated from the right side of each carcass and cut into steaks 2.54 centimeters thick. The steaks were vacuum packaged and assigned to aging treatments and were used for sarcomere length, 72-hour calpastatin activity assays, and fat and moisture analysis. Animal and location identity were maintained for all steaks. One steak from each carcass was used for fat and moisture determination. The second, third, fourth and fifth steaks were randomly assigned to be aged for three, seven, 14 and 21 days before Warner-Bratzler shear force (WBSF) measurements. Two other steaks were assigned to sarcomere length determination and 72 hour calpastatin assays.

Findings

Trial 1

The cattle in Trial 1 consisted of yearling fed steers from two sources. Within each contemporary group, the cattle were segmented into temperament categories (Calm, Intermediate, Excitable) based on exit velocity and pen scores taken before the cattle were transported to the feedlot. The differences were maintained in subsequent exit velocity measurements, although the magnitude of the difference diminished somewhat through the course of the study. This was probably partially due to the cattle's adaptation to being handled and the increased difficulty they had in moving through the working facility as they grew larger. Serum cortisol was higher in the Excitable cattle than the other groups at the preshipment sampling.

There were some slight differences in pH among the temperament groups. The application of electrical stimulation to all of the carcasses largely depletes muscle glycogen stores. In light of this, it is notable that the muscle metabolism was greater in the carcasses produced by the Excitable cattle. Muscle temperature did not differ between temperament groups at any time postmortem.

None of the carcass yield or quality grade characteristics differed between temperament groups. Though no statistical differences were evident, hot carcass weights and adjusted fat thickness were numerically greater for the cattle with calmer temperaments. The

researchers hypothesized that perhaps those animals possessed a slight advantage in growth and fattening ability due to their calmer temperament.

Steaks from the Excitable group in Trial 1 produced WBSF values that were higher than the Calm or Intermediate groups, which did not differ. Based on these results, it appears that the increased toughness in the Excitable cattle may be related to the extremely rapid pH decline observed in these animals.

Temperament group tended to affect adjusted fat thickness and USDA yield grade in these cattle. The cattle from the Excitable group had numerically lower adjusted fat thicknesses, as well as numerically lower yield grades. According to the researchers, these data may suggest that the Excitable cattle were more difficult to finish than those that were calmer.

In contrast to the temperament groupings made earlier in the feeding period, cattle classified as Excitable in the middle portion of the feeding period tended to have lower Warner-Bratzler shear force values than those with less excitable dispositions. In agreement with the findings regarding earlier sorting times, none of the biochemical traits measured differed with regard to temperament group. It appears that the relationship between temperament and muscle temperature changed as the animal aged. It also appears that the strongest relationship existed at the preshipment evaluation.

Trial 2

The cattle were sorted three times during the feeding period based on temperament in the same manner used in Trial 1. The temperament indicating measurements were consistent with one another and the differences between temperament groups was maintained throughout the feeding period. Similar to Trial 1, the differences between the groups decreased over time. While not statistically significant, higher cortisol concentrations were associated with greater excitability. None of the carcass traits was affected by the temperament classification. Similarly, temperament group had no effect on WBSF, proximate composition, muscle color, sarcomere length or calpastatin activity.

Trial 3

The third trial used yearling-fed Brahman steers. Sarcomere length was the only biochemical trait that was affected by temperament group. The differences in sarcomere length were not enough to produce a difference in Warner-Bratzler shear force between temperament groups. Similar to the other two trials, carcass characteristics were not affected by temperament group. Intramuscular fat content (based on ether extractions) tended to be lower for muscles from the cattle categorized as Excitable upon arrival at the feed yard than those characterized as being calmer. The means for extractable intramuscular fat were low in all of the temperament groups. Additionally, the reduced lipid content did not correspond to lower marbling scores.

Overall, measures of animal temperament appeared to rank animals consistently, and differences between temperament groups before shipment to the feedlot remained throughout the feeding period. Temperament affected tenderness in the yearling-fed cattle, but not in the calf-fed cattle. The primary difference between these two trials was time on feed. The yearling-fed steers were fed for 110 days, while the calf-fed steers were fed for 200 days. Based on these data, it appears that time on feed may play a role in influencing quality traits in cattle that are otherwise classified as excitable.

Implications

Results from this study were mixed, however temperament data collected before shipment to the feedlot was most effective in predicting tenderness. Warner Bratzler shear force values were relatively low in both trials. It was not clear what mechanism mediated the differences in tenderness, but the large difference in time on feed may have contributed to the differences in the relationship between tenderness and temperament classification observed between the trials.