Evaluation of Temperament and Transportation Stress on Body Composition Traits and Meat Quality in Beef Cattle

R. C. Vann, R. D. Randel, T. H. Welsh Jr., S. T. Willard, and J. A. Carroll

Introduction

Stressors can be psychological (restraint, handling, or novelty) or physical (hunger, thirst, fatigue, injury, or thermal extremes) (Grandin, 1997). Temperament has been associated with stress responsiveness in which higher concentrations of cortisol have been correlated with temperament of cattle (Curley et al., 2006; King et al., 2006). In addition, Smith and Grandin (1999) reported that appropriate handling of cattle and swine, as contrasted with improper or inappropriate handling, can result in improved productivity of live animals; in higher quality of slaughter livestock, carcasses, and cuts; and in greater profitability in the production and packing sectors. Voisinet et al. (1997) determined that feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. Additionally, over the past several years real-time ultrasound has provided a means in which to measure carcass traits (i.e., longissimus muscle area, rib fat, and intramuscular fat) in the live animal. For young cattle, quality grade is determined primarily by marbling, and ultrasound can provide an estimation of intramuscular fat which can be related to marbling in the carcass. Lipid deposition is believed to follow a set hierarchal pattern of omental, peripheral, subcutaneous, intermuscular, and intramuscular. However, certainly genetics, sex, health, implantation program, environment, stress, nutrition, and management all impact lipid deposition. Intramuscular fat is one of the last depot sites in beef cattle and also a fat that can be easily mobilized in times of nutrition or environmental stresses. For the past 4 years our research team has focused on elucidating the interactions between disposition and physiological stress on production performance in beef cattle. One aspect of this research involves the evaluation of the combined effects of transportation stress and animal temperament on real-time ultrasound body composition traits (primarily ultrasound intramuscular fat).

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Results and Discussion

Assessments of cattle temperament can be evaluated utilizing subjective measures [chute (Grandin, 1993) and pen scores (Kunkel et al., 1986)] and an objective measure utilizing chute exit velocity (Burrow et al., 1988). Chute scoring was adapted from Grandin (1993) where visual appraisals of each animal, while confined but not restrained in a working chute, were the basis of chute scoring. Pen scores (**PS**; Kunkel et al., 1986) were based on visual assessments of each animal while being confined to a pen with groups of 3 animals. Exit velocity (**EV**; Burrow et al., 1988) was determined as the rate at which the animal exited the working chute and traversed a fixed distance (1.83 m). Infrared sensors were used to remotely trigger the start and stop of a timing apparatus (FarmTek Inc., North Wylie, TX) to determine exit velocity. An overall temperament score that incorporates the pen score and exit velocity measures (PS + EV/2) provides a more accurate reflection of an animal's temperament than just one measurement alone. The following paragraphs will summarize results from studies which evaluated the effects on ultrasound body composition traits as affected by temperament and transportation stress and endotoxin challenge.

Study 1: Evaluation of Ultrasound Body Composition Traits as Affected by Temperament and Transportation Stress. The objective of this research was to evaluate the combined effects of transportation stress and animal temperament on real-time ultrasound body composition traits (primarily percentage of intramuscular fat) in Angus Crossbred (n = 68) and Brahman (n = 60) steers. Temperament scores (1 to 5 scale) were assigned at weaning, yearling, and before departure to the feedlot. Mean exit velocity (EV; m/s) was recorded at weaning, yearling, before de-

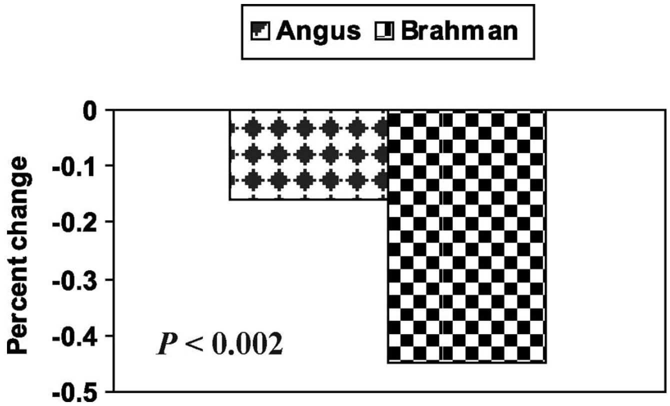

Figure 1. Percentage change in intramuscular fat as reflected by breed type.

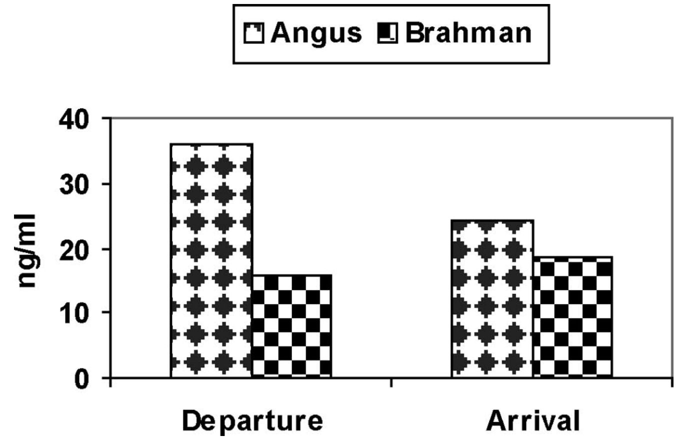

Figure 3. Cortisol concentrations by breed type at departure and feedlot arrival.

parture to the feedlot, and at feedlot arrival. Three sets of steers were hauled 3 distances (644, 809, and 1,236 km) to a feedlot. Body weights were collected at the same times as the mean exit velocity. Real-time ultrasound measurements for ribeye area, rib fat and rump fat, and gluteus medius depth were taken on steers before departure to the feedlot and again upon arrival at the feedlot. An overall temperament score was used which combined temperament score at weaning and yearling. Statistical analyses were performed using the Proc Mixed procedure of SAS utilizing repeated measures. Least square means were obtained from Proc Mixed procedure with main effects of sire breed and distance. Serum concentrations of cortisol were determined using RIA (ng/mL). Correlation coefficients between temperament scores at weaning and yearling were highly correlated ($r = 0.72$, $P = 0.001$). Overall temperament score reflected ($P = 0.001$) exit velocity and pen temperament score before departure to the feedlot. Breed and distance cattle were hauled affected ($P = 0.007$) exit velocity and percentage of intramuscular fat ($P = 0.053$) and rib fat ($P = 0.02$) at feedlot arrival (Figures 1 and 2). Angus crossbred steers hauled shorter distances had similar changes in percentage of intramuscular fat than Brahman steers. Brahman steers hauled the greatest distance had the greatest reduction in rib fat. As overall temperament score increased, cortisol concentrations also increased (Figures 3 and 4). These results suggest that hauling stress has negative effects on body composition traits, specifically percentage of intramuscular fat and rib fat. However, due to overall animal stress, overall temperament score did not impact body composition traits.

Study 2: Influence of Cattle Temperament, Transportation, and Lipopolysaccharide Challenge on Ultrasound Body Composition Traits. The objective of this study was to determine the influence of bovine temperament on ultrasound body composition traits in response to transportation and endotoxin challenge. Brahman bulls (10 mo of age) were selected on temperament score which was an average of exit velocity (objective measure) and pen score (subjective behavior score). The bulls with the lowest (C; n = 8; 0.87 m/s and 1 PS), intermediate (I; n = 8; 1.59 m/s EV and 2.25 PS), and highest (T; n = 8; 3.70 m/s and 4.88 PS) scores were used in this study. Prior to transportation (de-

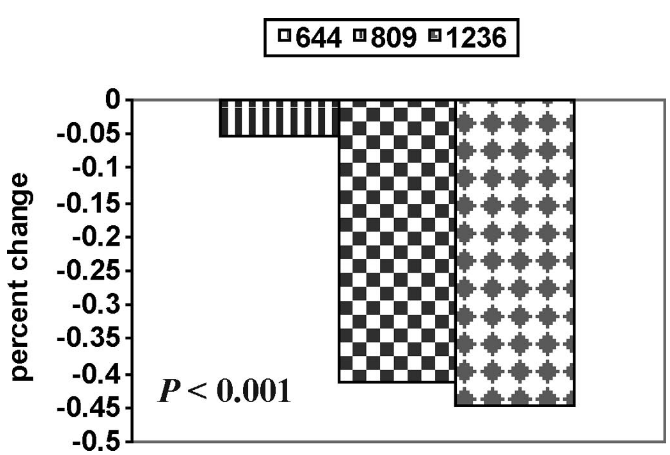

Figure 2. Percentage change in intramuscular fat as indicated by travel distance.

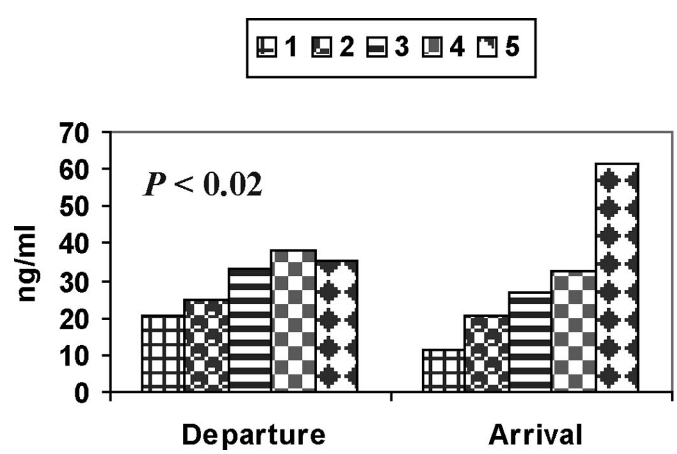

Figure 4. Cortisol concentrations as reflected by temperament score.

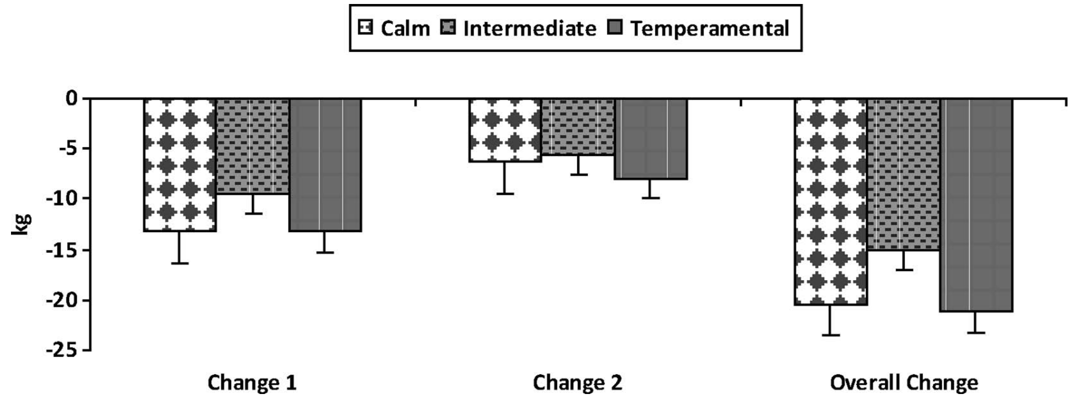

Figure 5. Body weight changes (kg) of Brahman bulls posttransportation and after lipopolysaccharide (LPS) challenge and postLPS from day of departure.

parture), after transportation (770 km) and post-lipopolysaccharide (**LPS**) challenge body weights and ultrasound body composition measurements for longissimus muscle area (**LMA**), percentage of intramuscular fat, rib fat (**RF**), and rump fat were collected. Data were analyzed using the PROC Mixed procedure of SAS for repeated measures where appropriate. Body weights decreased (average 18.6 ± 55 kg; Figure 5) for all temperament groups from date of departure through postchallenge LPS ($P < 0.001$). A temperament score × day interaction ($P < 0.05$) for LMA was evident in the T bulls (–2.62 ± 1.44 cm^2) having a greater change in LMA from departure to postchallenge LPS compared with C (–1.54 ± 1.54 cm^2) and I (–1.62 ± 1.44 cm^2) bulls (Figure 6). There was a numerical trend for bulls classified as T (–0.15 ± 0.11) to have the smallest decrease in percentage of intramuscular fat compared with the C (–0.41 ± 0.11) or I (–0.43 ± 0.11) bulls due to transportation or postchallenge LPS (Figure 7). Rib fat thickness was reduced (average 0.03 ± 0.03 cm) due to transportation for bulls in all temperament classifications ($P < 0.03$; Figure 8). Bulls classified as T (0.004 ± 0.003) had the smallest reduction ($P < 0.07$) in RF compared with the C (–0.05 ± 0.03) or I (–0.04 ± 0.03) bulls postLPS challenge (Figure 8). Minimal changes in rump fat occurred during this study (Figure 9). Bull body weight and RF was reduced due to transportation and postchallenge LPS. Although many of the changes in ultrasound body composition traits due to transportation and postLPS challenge are minimal, there are some trends; however, more research needs to be done to further elucidate these changes.

Summary

Transportation stress does negatively impact body composition traits, especially intramuscular fat in young steers transported to the feedlot or bulls undergoing transportation and an endotoxin challenge. These changes are minimal in younger growing animals; however, the trend is evident and further research is needed to elucidate these changes. This would also indicate that fat cattle transported long distances to a harvest facility could undergo the same type of changes in percentage of intramuscular fat and thus could have an impact on cattle marketed on a grid system.

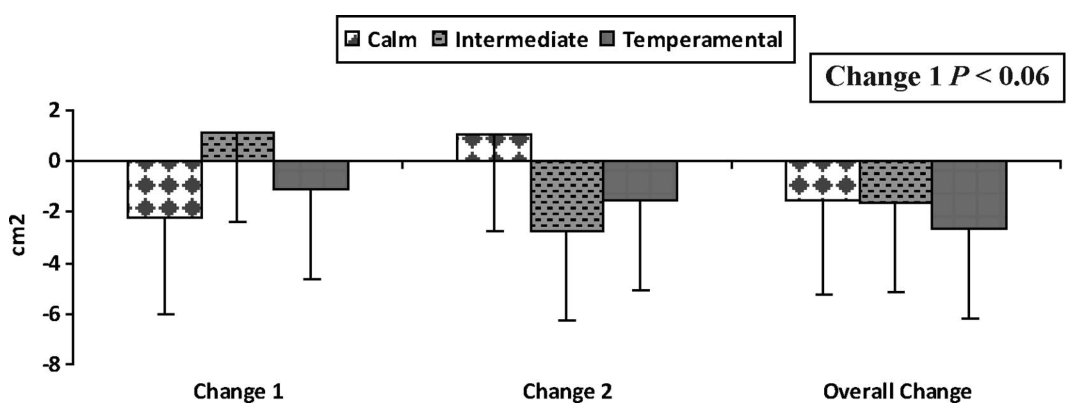

Figure 6. Longissimus muscle changes (cm^2) of Brahman bulls posttransportation and after lipopolysaccharide (LPS) challenge and postLPS from day of departure.

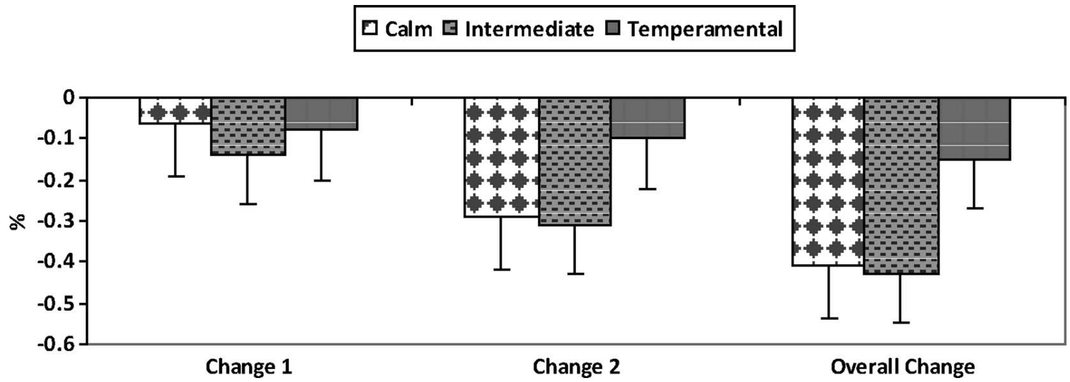

Figure 7. Percent intramuscular fat changes (%) of Brahman bulls posttransportation and after lipopolysaccharide (LPS) challenge and postLPS from day of departure.

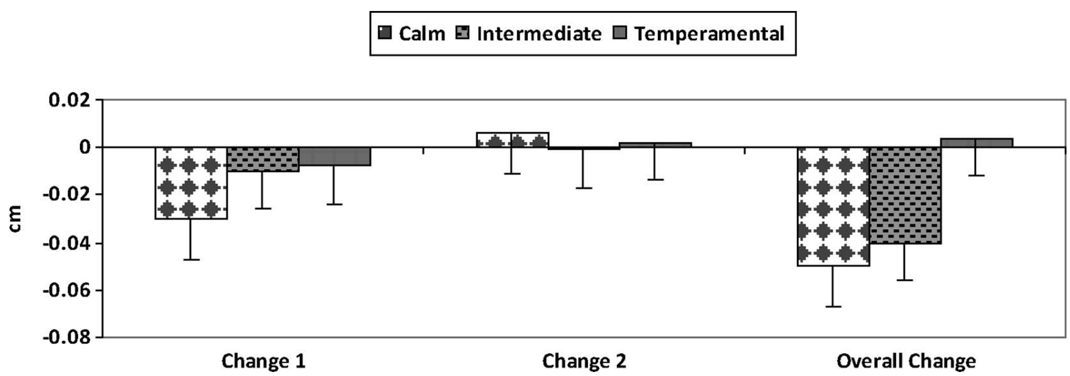

Figure 8. Rib fat thickness (cm) changes of Brahman bulls posttransportation and after lipopolysaccharide (LPS) challenge and postLPS from day of departure.

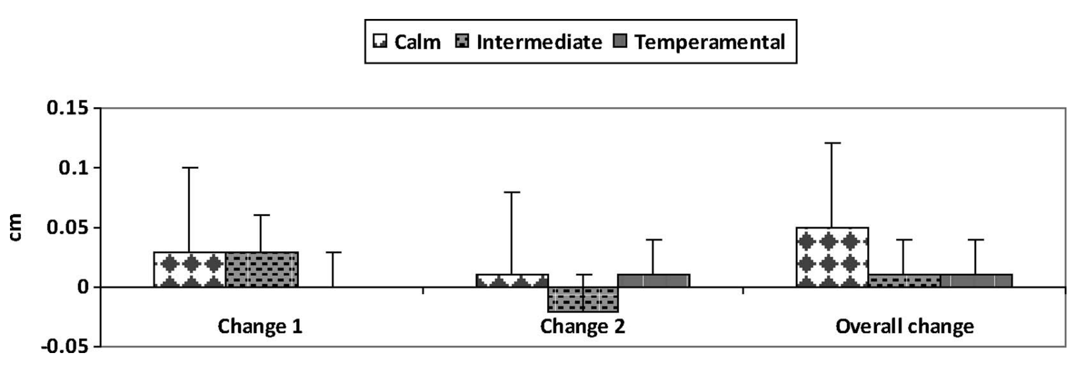

Figure 9. Rump fat thickness (cm) changes of Brahman bulls posttransportation and after lipopolysaccharide (LPS) challenge and postLPS from day of departure.

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