Florida Cattle Enhancement Fund
Final Report
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# Relating Growth to Beef Tenderness and Thermotolerance of Brahman steers

Investigators: Tracy Scheffler, Chad Carr, and Jason Scheffler
Department of Animal Sciences, University of Florida; Gainesville, FL 32611
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## Background and Specific aims

Properties related to muscle function and metabolism in the live animal influence development of meat quality attributes. Specifically, the calpain-calpastatin system influences muscle growth and protein turnover in the live animal, and it is also the major system governing tenderization of beef. Bos indicus cattle possess elevated calpastatin content in muscle, which diminishes protein degradation and results in tougher beef. Several genetic markers for calpain and calpastatin have been identified and validated for selection, but variation in tenderness remains a problem in Brahman cattle. Although increased calpastatin is a well-documented phenomenon, the regulation of its content in muscle and its physiological significance to thermotolerance in Brahman cattle is poorly understood. Therefore, *our goal* is to better understand the relationships between growth, the calpain-calpastatin system, tenderness, and heat tolerance, in order to *improve beef quality and enhance value of Bos indicus cattle.*

Our objectives are to

- determine if we can generate differences in calpastatin content and tenderness by selecting Brahman steers with different growth rates
- assess the relationship between growth, calpastatin content, and thermotolerance by subjecting steers to heat stress.

Completion of these objectives will improve our understanding of the relationship between growth, tenderness, and heat tolerance in Brahman steers by

- Determining contribution of protein degradation to differences in growth rate
- Relating animal and muscle growth to beef tenderness
- Defining if growth rate or calpastatin content impacts heat tolerance

Understanding the relationships between growth, tenderness, and heat tolerance may lead to management and selection strategies that can enhance postmortem tenderization, without sacrificing thermoregulatory capacity of Bos indicus breeds.

## Approach

**Animals**. Purebred Brahman steers for this study were selected from the University of Florida herd. Calves were born between mid-December 2015 and early March 2016, and weaned from their dams in August. A corrected 205 day weight was calculated; approximately 60 days later, calves were reweighed and allocated to the “high” or “low” growth group based on the weight difference from the 205 day corrected wt and the 60 day subsequent actual wt. In order to maintain similar genetic background, high and low growth steers were paired by sire. In April 2017, steers (n = 6 pair) were moved from Beef Research Unit to the Beef Teaching Unit (BTU) to acclimate steers to handling. Subsequently, two pairs were eliminated for poor temperament. In late May, steers were transported to environmental rooms at the UF Animal Science (ANS) building for the heat challenge portion of the experiment.

**Environmental rooms and heat challenge**. Steers were housed in individual pens (26.5 $ft^2$) in temperature-controlled chambers in two mirrored rooms, with 4 pens per room. Two high and low growth steers (two pairs) were represented in each room. Steers were given 19 d for acclimation at thermoneutral temperatures (average ~80°F; 80% relative humidity, RH) prior to treatment. The experiment was initiated on d 0; wall mounted heaters were used to increase room temperature (average ~95°F, 55-60% RH). Steers were subjected to high environmental temperatures for 16d. Room temperature and relative humidity were logged every 5 min using HOBO data logging devices (Onset Computer Corporation; Bourne, MA; Fig. 1). At the conclusion of the heat challenge period, steers remained at the ANS building for 3 d (d 17-19; ~83°F, 80% RH) for post-treatment data collection. Subsequently, steers were returned to the UF Beef Teaching Unit for the finishing phase.

**Management**. Throughout the study, cattle were provided water ad libitum via individual water bowls with paddles; water flow meters recorded the running total of water consumption for each bowl. Daily water intake was calculated based on the change in water flow between values recorded at 0830 on consecutive days. Bermudagrass hay was provided ad libitum. Commercial feed was offered at 1.2% body weight per day in two feedings (0830 and 1700 daily) and top dressed with mineral supplement as directed; any feed remaining at the following feeding was weighed.

**Sample collection**. Respiration rate and rectal temperature were measured three times daily (0800, 1200, and 1700). Respiration rate was determined by counting flank movement over a 30 s interval and converting to breaths/min. Rectal temperature was assessed using a digital thermometer with probe inserted approximately 4 inches into the rectum (Ag Medix AG-102 thermometer; accuracy ±0.1°F). Temperature was also measured using calibrated data loggers (thermocrons or I buttons; Embedded Data Systems; Lawrenceburg, KY) positioned on the tail vein, approximately 3 inches from the anus; loggers recorded temperature every 10 min.

**Muscle biopsies**. In order to evaluate changes in muscle proteins related to heat challenge, muscle biopsies from the loin (*longissimus*) were obtained on d 0, immediately prior to initiation of heat challenge; and on d 16 at conclusion of heat challenge period. Blood was also collected at d 0 and d 16.

## Results

**Animal performance.** In order to establish low and high growth groups, steers were separated based on post-weaning growth performance. Thus, the low and high growth groups exhibit differences ($P < 0.05$; Table 1) in weight at weaning and 73 d after weaning (10/20/16). These differences have continued throughout the study. However, post-heat challenge rate of gain is not different between the groups.

**Temperature and Respiration.** Temperature and respiration rate were monitored for 5d prior to initiation of heat challenge to establish baseline values. Compared to baseline, average daily rectal temperature was elevated ($P < 0.05$) on days 0, 2 to 7, 10, 11, and 13 to 16 during the heat challenge period. Temperature tended ($P = 0.06$) to be greater than control on d 8. From d 0 to 8, average temperature was approximately 0.5°F greater than baseline, and from d 9 to 16, average temperature was more variable but roughly 1.0°F higher than before the heat challenge. Therefore, prolonged exposure to elevated environmental temperatures caused a significant increase in rectal temperature, supporting that heat loss mechanisms of growing Brahman steers were unable to fully compensate for increased heat load. Temperature was also evaluated after exposure to high environmental temperature; rectal temperatures on d 17 differed from baseline ($P < 0.05$), and curiously, were numerically lower than the during the acclimation period. Similarly, respiration rate differed from baseline on days 1 through 16 of the heat stress period. Exposure to elevated environmental temperatures resulted in respiration rate increasing more than two-fold.

**Feed and water intake**. Intake of commercial feed in the heat challenge period was not different than baseline. Consumption of hay could not be accurately determined, but appeared to decline during heat challenge. As expected, water intake increased during the heat challenge period. Steers consumed approximately 50% more water during heat challenge than during the baseline period.

Table 1. Weight (lbs) of steers selected for low and high growth groups.[1]

| | Weight (lbs) | | | |
|---|---|---|---|---|
| Date | Low | High | SE | *P*-value |
| 8/8/16 | 435.0 | 522.5 | 21.1 | 0.03 |
| 10/20/16 | 531.3 | 667.5 | 28.4 | 0.01 |
| 6/13/17 | 783.8 | 882.5 | 16.8 | 0.004 |
| 6/29/17 | 810.0 | 893.8 | 20.1 | 0.03 |
| 8/21/17 | 947.5 | 1022.5 | 17.8 | 0.02 |

[1]Steers were weaned on 8/8/16 and selection for high and low growth groups was made on 10/20/16. Heat challenge was initiated on 6/13/17 and concluded on 6/29/17.

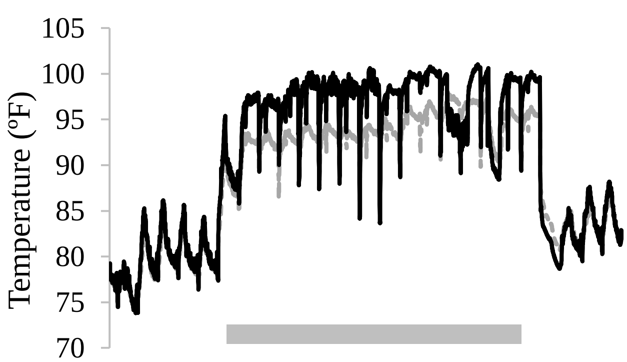


Figure 1. Temperature in environmental rooms (black and gray lines) throughout the experimental period. The gray bar represents the heat challenge period.

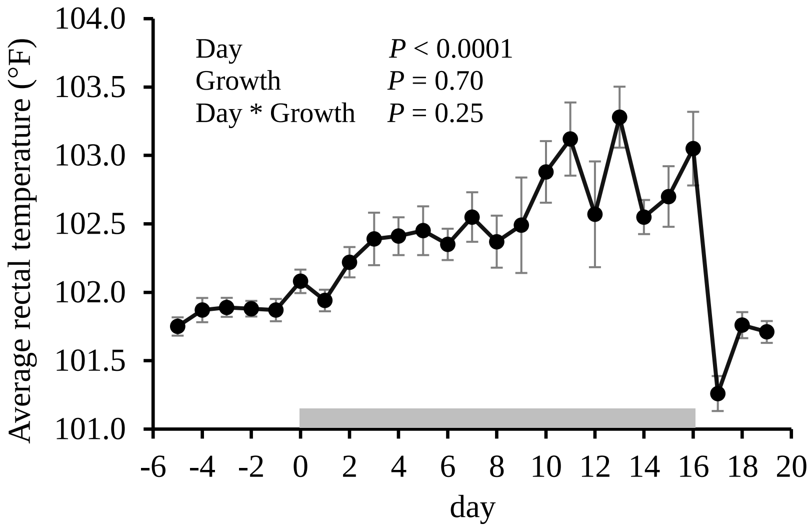


Figure 2. Average rectal temperature of steers throughout the experimental period. The gray bar represents the heat challenge period.

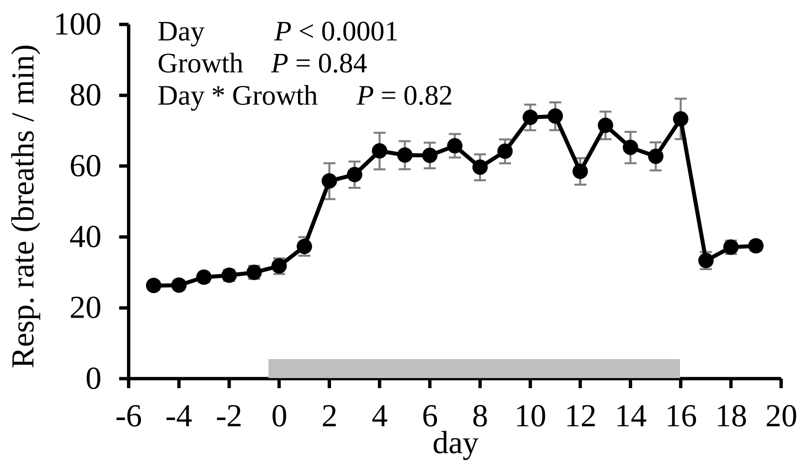


Figure 3. Average rectal temperature of steers throughout the experimental period. The gray bar represents the heat challenge period.

**Current status and next steps**

Steers are currently at the UF BTU and are being fed a standard corn-protein finishing diet. Weights range from 900-1050 lb (8/21/17). Steers are targeted for slaughter at 0.4 inches subcutaneous fat. Based on weights and rate of gain, anticipated slaughter date has been rescheduled for January 2018. Additional loin samples will be collected at harvest (within 1h after slaughter), and at 8h, 24h and 14d postmortem. This information will be used to establish relationships between growth performance, calpastatin, heat tolerance, and tenderness.

A replication of this experiment is planned for spring 2018. Purebred Brahman steers were recently weaned, and post-weaning growth will be assessed in roughly two months.

| Budget for Florida Cattlement Enhancement Fund<br>**Project: FCEB 34**<br>**Relating Growth to Beef Tenderness and Thermotolerance of Brahman steers** | | | | | |
|---|---|---|---|---|---|
| **Detailed line item description** | **Qty** | **Unit price** | **Total** | **Explanation/Justification** | **Completion date** |
| Animals - lost value | 4 | $1,250 | $5,000.00 | Opportunity cost; potential lost revenue due to castration of higher quality bulls | 9/1/2017 |
| Animal care | various | various | $22,765.00 | Costs for materials for animal transportation, care, handling, feeding during trial; costs for personnel to oversee study (graduate student) and personnel to acclimate animals to handling, feed and monitor animals and clean rooms | 9/1/2017 |
| Animal feed | various | various | $2,815.00 | Pasture per diem and feed during study | 9/1/2017 |
| Animal experiment - sample collection | various | various | $5,035.00 | Costs for monitoring facility and animal temperature, includes i-buttons and data loggers; muscle biopsy equipment & services; slaughter fees & product devaluation | 9/1/2017 |
| Laboratory analyses | various | various | $32,515.00 | Costs for materials and supplies for processing muscle samples, histology, Western blot, & tenderness analyses; equipment for sample processing (centrifuge); and personnel to conduct analyses | 9/1/2017 |
| Materials & supplies | various | various | $760.00 | Heaters for environmental rooms, scale | 9/1/2017 |
| Final report | | | | | 9/1/2017 |
| **Grand total** | | | **$68,890.00** | | |