Project Summary

Determine the Genetic and Phenotypic Variances of Meat Quality Traits and their Interrelationships with Economically Important Traits in *Bos Indicus* Type Cattle

Principal Investigators: Gordon Carstens, Ph.D., Rhonda Miller, Ph.D., Texas A&M University, Luis O. Tedeschi, Ph.D., John Pollak, Ph.D., Cornell University, Paul Genho, Ph.D., Scott A. Moore, Ph.D., King Ranch

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Background

Feed efficiency is an important trait to consider in cattle selection programs to reduce the cost of gain. Current genetic selection strategies focus primarily on output traits in cattle such as growth and carcass traits. Selection strategies are needed that will improve efficiency of feed utilization, but not adversely affect performance traits or compromise carcass quality.

Feed conversion ratio (FCR) has been the traditional trait used to assess feed efficiency in cattle, however it is moderately heritable and has a negative correlation with growth traits and mature size. An alternative trait is needed that will quantify differences in feed efficiency independent of differences in growth traits.

Two recent selection tools have been developed that improve the potential to identify more efficient cattle: 1) Development of an alternative feed efficiency trait (net feed intake; NFI), and 2) A mathematical model (Cornell Value Discovery System; CVDS) to estimate feed required for specific performance levels. The NFI value is calculated as actual feed consumed minus an animal's expected feed intake based on average daily gain and body weight. In other words, NFI is calculated as the difference between actual dry matter intake (DMI) and the DMI an animal is expected to consume based on its size and growth rate. Cattle that are larger and grow faster would be expected to consume more feed than cattle that are smaller and grow slower.

The primary limit to implementing selection programs to improve NFI is the difficulty and expense of measuring individual feed intake. Identification of physiological indicators (e.g. hormones) or other measurements that are predictive of NFI would be useful as early screening tests.

There are currently two genetic tests for tenderness that are commercially available to use in selection for tenderness (polymorphisms related to calpain and calpastatin genes). Validation of these tests has been conducted with Warner Bratzler shear force, however as the industry moves toward image-based grading systems (e.g. CVS BeefCam® Tenderness Module), it will be important for producers to know that genetic tests for live cattle are indicative of the tenderness measures generated by image-based grading technologies.

The objectives of this project were multifaceted and included the following:

1. Examine the relationships between feed efficiency measured in growing steers fed a roughage based diet and feed efficiency measured in finishing steers fed a grain-based diet.
2. Examine the relationships between growing and finishing feed efficiency traits and ultrasound estimates of carcass composition measured during the study and carcass composition, tenderness and other quality attributes measured at harvest.
3. Examine the relationships between indicator traits of stress (exit velocity and serum cortisol and IGF-I concentrations), and performance, carcass and feed efficiency traits.

4. Validate the CVDS model estimates for feed efficiency, lean muscle composition, and overall sensitivity of the CVDS predictions.
5. Examine relationships between two commercially available genetic markers for tenderness (DNA polymorphisms related to calpain and calpastatin) and Warner-Bratzler shear force with measurements obtained with the CVS BeefCam® Tenderness Module.

Methodology

Santa Gertrudis steers (n = 120) were placed in pens equipped with Calan gate feeders to measure individual feed intakes. Wherever possible, at least two steers per sire group were represented in each pen. Steers were adapted to a roughage-based diet and trained to eat from Calan gates for 21 days. At the end of the adaptation period, steers were individually fed for 77 days to determine growing phase net feed intake. Steers were then adapted to the high-grain diet for 21 days, and then fed for 80 days to determine finishing phase net feed intake. During both the growing and finishing periods, steers were weighed weekly, diets were fed ad libitum twice daily and feed refusals were measured weekly.

Ultrasound measures of the twelfth rib fat thickness, ribeye area and intramuscular fat were obtained at the start and end of the growing period, and on day 70 of the finishing period. Steers were also assigned a subjective temperament score in the squeeze chute (1 = calm; 5 = continuous vigorous movement). Steers were evaluated for how quickly they exited the chute at the start and end of the growing period, and on day 70 of the finishing period. Blood samples were collected four times throughout the trial and analyzed for corisol and insulin growth factor-I (indicators of stress levels).

Steers were harvested at a commercial processing facility at a common backfat thickness endpoint of 0.4 inches. After a 24-hour chill, a 50-gram sample of the *longissimus dorsi* muscle was collected to determine calpastatin activity. After a 48-hour chill, carcass characteristics (skeletal and muscle maturity, 12^{th} rib fat thickness, ribeye area, kidney-pelvic-heart fat and marbling score) were collected to determine yield and quality grade. The sixth to 12^{th} rib section was removed, vacuum packaged and stored for further analysis. Two steaks were cut from the 12^{th} rib section and randomly assigned to a one or 14-day aging period. Steaks were measured for tenderness using Warner Bratzler shear force tests. The ninth to 11^{th} rib section was dissected into separable fat, lean and bone tissue, and soft tissue was subsequently analyzed for moisture, lipid and protein content to determine carcass and body composition.

Data were collected to calculate net feed intake (NFI) and to evaluate the Cornell Value Discovery System (CFDS) model. An additional set of steers and heifers (n = 451; contemporaries of the steers used in the previously described study) were also used to evaluate the CVDS system. The cattle were fed a receiving diet for 30 days upon arriving at the feedyard facility. During the finishing period, the calves were weighed at 28-day intervals. Ultrasound measurements were obtained prior to the calves being shipped for harvest. The cattle were harvested at a commercial processing facility where yield and quality grades were determined and steaks were collected for WBSF evaluation. Complete carcass cooler data and WBSF were obtained for 442 carcasses. As carcasses were presented for grading, a digital image of the 12-13^{th} rib interface was collected with a CVS Beef CAM (n = 325 carcasses). This image was used to generate information to predict WBSF, back fat, ribeye area and yield and quality grades.

Findings

Of the three feed efficiency traits (feed conversion ratio, FCR; partial efficiency of growth, PEG and net feed intake, NFI) examined, NFI was the least influenced by growth, carcass composition traits and initial body weight. During both the growing and finishing phases, steers with low NFI consumed 18 to 19 percent less feed and had 19 to 23 percent lower feed conversion ratio than steers with a high NFI. Evaluation of the Cornell Value Discovery System model to predict FCR revealed strong correlations with the actual feed conversion ratio.

Although not numerically significant, steers with low net feed intake had numerically less ninth to 11th rib fat than steers with high net feed intake. Carcass ribeye area was not correlated with growth or feed efficiency traits. Protein content was not significantly correlated with feed conversion ratio or net feed intake, although it was correlated with partial efficiency of growth. These results indicate that selection for improved net feed intake in cattle fed high-grain diets will result in slightly leaner cattle, with minimal effects on ribeye area or carcass protein content. Correlations with ultrasound measurements also indicated that growing calves with low net feed intake (more efficient) will be slightly leaner than steers with high net feed intake.

Of the feed efficiency traits measured during the finishing phase, partial efficiency of growth was the most, and net feed intake was the least, correlated with marbling score and quality grade. Steers with favorable PEG and FCR had lower marbling scores and quality grades. Warner-Bratzler shear force was unfavorably correlated with partial efficiency of growth, but not feed conversion ratio or net feed intake. Calpastatin activities were favorably correlated with feed conversion ratio and net feed intake.

Serum IGF-I concentration measured on day 0 of the growing phase were correlated with ultrasound estimates of ribeye area, backfat and intramuscular fat measured at the end of the growing phase and the results suggested that steers with low serum IGF-I concentrations will be leaner.

Table 1. Phenotypic correlations[a] between carcass traits obtained at slaughter, and performance and feed efficiency traits in finishing steers.

Trait[b]	ADG	DMI	FCR	PEG	NFI
Carcass cooler traits					
Hot carcass weight (HCW)	0.56	0.72	-0.03	-0.34	0.02
Ribeye area (REA)	0.15	0.10	-0.09	0.01	-0.10
Backfat thickness (BF)	0.34	0.55	0.06	-0.42	0.29
Marbling score	-0.04	0.11	0.17[c]	-0.30	0.13
Yield Grade	0.37	0.58	0.04	-0.42	0.27
Quality Grade	0.005	0.16[c]	0.17[c]	-0.36	0.12
Tenderness traits					
Day-1 WBSF	-0.15	-0.22	-0.05	0.23	0.04
Day-14 WBSF	-0.04	-0.10	-0.09	0.09	0.07

Calpastatin activity	0.16[c]	0.29	0.04	-0.16[c]	0.17[c]
9-11th rib composition					
Protein	-0.16[c]	-0.27	-0.02	0.29	-0.12
Lipid	0.30	0.42	0.01	-0.40	0.22
Ash	-0.27	-0.37	0.002	0.32	-0.16[c]

[a] Correlations in bold are different from zero at P <0.05.
[b] Correlations are different from zero at P < 0.10.
[c] DMI = dry matter intake; FCR = feed conversion ratio; PEG = partial efficiency of growth; NFI = net feed intake; WBSF = Warner Bratzler shear force

Implications

Overall, these results suggest that more efficient steers, or those identified as having low net feed intake during the finishing phase, were slightly leaner, but were not different in tenderness or marbling compared to steers with high net feed intake. Selecting for efficiency traits would not necessarily negatively affect carcass composition traits.

For more information contact:
National Cattlemen's Beef Association
9110 East Nichols Avenue
Centennial, Colorado 80112-3450
(303) 694-0305