Project Summary

Interactive Effects of Tenderness Genotype and Growth Enhancement Technologies on Performance and Beef Tenderness in Feedlot Heifers

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Background

Factors affecting beef tenderness continue to be a major concern for the beef industry. It has been well documented that genetics, nutrition, management and environment all have major impacts on beef tenderness. Tatum (2006) showed that four process-control points for tenderness include: (1) control of breed or genetics, (2) use of optimal feeding systems, (3) judicious application of growth-enhancement technologies, and (4) adherence to best management practices to avoid tenderness problems associated with morbidity, pre-harvest stress, and administration of animal health products. The use of growth-enhancement technologies (e.g., anabolic implants, β-adrenergic agonist) is known to sometimes negatively affect tenderness, but the continued use of these products is critical in order to increase rate and efficiency of weight gain and improve net revenues from beef production systems. While breed type also affects beef tenderness, it is widely recognized that the magnitude of inter-animal variation in tenderness within a breed exceeds the differences in tenderness typically seen between breeds. Recent developments of genetic markers for beef tenderness provide opportunities to select for improved tenderness within breed or biotype. However, few studies to date have attempted to determine if growth-enhancement technologies differentially affect beef tenderness in cattle with divergent genotypes for tenderness (tender vs. tough based on DNA marker tests). Knowledge of specific interactions between tenderness genotype and the use of growth-enhancement technologies on beef tenderness will provide opportunities to develop specific marker-assisted management systems for cattle with tough and tender genotypes to meet target markets (e.g., high-tender beef). Better understanding of the interactions between genetics, sex and growth-enhancement technologies will help the U.S. beef industry to better respond to consumer demands for more tender and more consistent beef products.

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Methodology

Santa Cruz heifers from the King Ranch (n ~350) were evaluated by Pfizer Animal Genetics using their current commercial tenderness marker. The heifers that were determined to be the most tender (n=68) and most tough (n=68) using the tenderness marker were selected at weaning. When heifers were about 700 lbs, they were placed on a corn-based finishing diet for about 150 days. Within a tenderness group, heifers were randomly assigned one of four growth enhancement treatment groups: 1) control or no treatment; 2) implanted first with Revalor IH and 70 days later with Revalor H; 3) fed a *B* agonist of Optaflexx the last 28 days of the study; or 4) implanted as 2) above and fed Optaflexx the last 28 days of the study. Heifers were sorted by weight, light or heavy, and fed within weight group in pens.

When heifers within weight group were at a 12th rib fat endpoint of 0.4 inches, they were commercially harvested and USDA Yield and Quality grades were determined along with pH and lean color. The loin was removed from one side and cut into six, 1-inch steaks. Steaks randomly were assigned for Warner-Bratzler shear force tenderness measurements after 1, 7, 14 or 28 days aging or slice shear force tenderness assessment after one and 14 days. Chemical fat, moisture, sarcomere length and desmin content as an indication of protein degradation during aging also were conducted.

Findings
Tenderness marker class did not impact USDA Yield and Quality grade characteristics indicating that selection of heifers for tenderness using the Pfizer tenderness marker would not affect beef carcass characteristics. As was expected, growth enhancement treatments influenced ribeye area, percentage kidney, pelvic and heart fat and lean color score. Carcasses from heifers implanted and fed beta-agonists had larger ribeye areas and less kidney, pelvic and heart fat; and Yield grade tended to be lowest for carcasses from heifers implanted and fed beta-agonists. Carcasses from tough, control heifers had higher marbling scores than carcasses from tough, beta-agonist and tender, implant and beta-agonist treatments. These differences were almost a half of a marbling score and would impact the percentage Choice within a treatment group.

Steaks from tender heifers tended to be more tender than steaks from tough heifers using Warner-Bratzler and slice shear force values. Variation in tenderness measures decreased and steaks were more tender with increased aging for Warner-Bratzler shear force measures, but most of this reduction was seen from one to seven days. Differences in tenderness was most likely due to differences in protein degradation during aging as desmin amounts, the protein that is indicative of the aging process, showed that meat from tough heifers had higher desmin concentrations. Carcasses in this study did not differ in sarcomere length as they were all electrically-stimulated at harvest.

Growth enhancement treatments affected beef tenderness measures. Steaks both implanted and heifers fed beta-agonist were tougher than steaks from untreated, implanted or beta-agonist only heifers. Tenderness marker classification may affect how toughness was expressed in heifers that were subjected to implant and/or beta-agonist growth enhancement treatments. If heifers have the genetic propensity to be tough, feeding beta-agonist alone or in combination with implant strategies results in tougher meat; however, if heifers have the propensity to be tender, using an implant or beta-agonist alone as growth enhancement strategies will not affect tenderness. For these tender heifers, tenderness is not impacted until both implant and beta-agonist growth enhancement treatments are implemented. After 14 days of post-harvest storage, differences in tenderness were not reported.

Implications
A Texas-based plant has identified heifers as having more tenderness variation than steers, based on data from slice-shear tests across a large number of cattle. With the advent of automated grading systems to quantify tenderness, it is likely that the industry will soon be able to establish market value based on tenderness. Therefore, a better understanding of the production factors that are responsible for increased variation in tenderness of heifers was needed.

While the cause of gender-related variation in tenderness was largely unknown, it has been hypothesized that genetic propensity to produce tender beef interacts with management strategies (e.g., implants, β-adrenergic agonists, MGA) and environmental factors to cause higher variation in tenderness of meat from heifers. Recent advances in animal-genomic technologies have yielded commercial DNA tests to select cattle for tenderness and other economically-relevant traits in beef cattle. These DNA genetic marker tests also provide opportunities to develop marker-assisted management systems that sort individual calves upon feedlot entry into targeted production-outcome groups (e.g., high-tender beef) to reduce within-group variance of beef product-related traits, thereby improving predictability and consistency of beef products.

The discovery of significant interactions between meat tenderness genotype (based on DNA tests for tenderness) and the use of growth-enhancement technologies will further refine development of marker-assisted management systems such that growth-enhancement technologies will be selectively used on targeted genotypes (e.g., high-tender beef) to improve performance and efficiency of weight gain while optimizing product-quality targets. Thus, the strategic use of growth-enhancement technologies for targeted genotype groups will enhance overall production efficiency, reduce market risks, and optimize product quality and value. The successful development of marker-assisted management systems to optimize productivity of individual animals based on their trait-specific genotypes will allow the beef industry to capitalize on the potential value of genomic technologies to meet consumer demands for consistent high-quality beef products that are competitively priced relative to other meat-protein products. Study results show that there are interactions between meat tenderness genotype groups and growth enhancement strategies, and that genetic differences in tenderness may exist even after 28 day of aging.

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