Project Title: Effects of Genetic Tenderness Markers in Cattle Receiving Differing Implant Protocols

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Background

The vast majority of fed cattle in the U.S. receive anabolic implants, which are broadly classified according to their impact on growth. The general trend is that the more "aggressive" (i.e. larger impact on growth) an implant, the more detrimental its effects are on carcass and meat quality. Cattle often receive multiple implants during their lives as they move through various segments of the industry. The available literature regarding lifetime implanting strategies indicate that these implants may have cumulative effects on tenderness. Therefore, the use of "aggressive" implant strategies, even at early stages of production, can be contrary to industry needs for maintaining customer satisfaction, and consequently, market share.

Research data collected on a wide variety of treatments indicate that, even when a treatment has large, detrimental effects on tenderness, some animals given those treatments produce acceptably tender meat. Several genetic markers for tenderness are commercially available. Two single nucleotide polymorphism (SNP) based markers, corresponding to the calpain gene ($CAPN1_{4751}$; White et al., 2005 and $CAPN1_{316}$; Page et al. 2004) and one associated with the calpastatin gene (CAST; Casas et al., 2006) have been reported to have small, additive effects on tenderness (Casas et al., 2006). This study addressed the hypothesis that selecting for favorable alleles of these markers would help mitigate the negative effects of management practices such as the use of "aggressive" growth promotants.

The objectives for this project was to characterize the effectiveness of genetic markers for tenderness in cattle treated with differing implant strategies, and to evaluate the effects of those markers for tenderness on growth and carcass traits.

Methodology

A population of British × British and British × Continental crossbred cattle from the U.S. Meat Animal Research Center (n = 448) were sorted by sire line and dam line, and randomly assigned to one of two implant strategies (mild or aggressive). The cattle were also assigned to one of eight management groups. The mild implant protocol consisted of a terminal Revalor IS (steers) or Revalor IH (heifers) implant. The aggressive implant protocol consisted of two successive Synovex Plus implants. Cattle from the lightest management groups that were assigned to the aggressive protocol also received a Revalor G implant approximately 100 days before the first Synovex Plus implant. After slaughter, carcass yield and quality grade data were collected and a *longissimus lumborum* steak was obtained, aged for 14 days and used for slice shear force determination. Cattle were genotyped using the $CAPN1_{316}$, $CAPN1_{4751}$ and CAST markers, which are part of commercially available genetic tests for tenderness.

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Findings

The aggressive implant protocol caused a small increase in carcass leanness and muscling, but also caused a decrease in tenderness and marbling score. Additionally, the extent of protein degradation was limited in steaks from the aggressively implanted cattle. The T allele of the $CAPN1_{4751}$ marker was associated with additive reductions in tenderness (Table 1). This allele was also associated with decreased final live weight and increased average daily gain. The $CAPN1_{316}$ polymorphism was segregating at low levels in the cattle used in this study; however, substituting the G allele for the C allele of the $CAPN1_{316}$ marker caused linear increases in slice shear force, and linear decreases in protein degradation. The C allele also was associated with higher marbling scores. The C allele of the $CAPN1_{316}$ marker also was associated with more subcutaneous fat and higher yield grade. The majority of the animals in this study possessed the T (favorable) allele for the CAST polymorphism. Substituting the C allele for the T allele of the CAST marker resulted in linear increases in slice shear force. The T for this marker also tended to increase marbling scores. These results indicate that genetic markers can be used to select animals to improve tenderness even when growth promotants with negative effects on tenderness are used. Such selection may also influence other traits as well.

Table 1. Least squares means for the effects of implant protocol and genotype at three SNP markers for tenderness on slice shear force, kg for the CAST polymorphism effects on tenderness and carcass traits

	Implant protocol			Genetic marker number of negative alleles					
Trait	Mild	Aggressive	P > F	0	1	2	P > F	Linear	Quadratic
$CAPN_{14751}$	16.97 -0.42	18.55 -0.4	<0.01	16.67[y] -0.47	17.46[y] -0.38	19.15[z] -0.63	<0.01	<0.01	0.41
$CAPN_{1316}$	14.93 -0.99	17.57 -0.73	0.03	14.21[y] -1.72	16.23[y] -0.54	18.31[z] -0.35	<0.00 1	<0.02	0.97
CAST	18.26 -0.91	18.88 -0.91	<0.63	16.86[y] -0.36	18.54[z] -0.57	20.30[z] -1.81	<0.01	<0.06	0.97

Implications

Economic considerations dictate that cattle producers use every opportunity to increase the rate and efficiency of gain. Many of the technologies that provide such efficiencies have negative impacts on meat quality. This research demonstrates that currently available genetic markers for tenderness provide improvements in tenderness regardless of which implant protocol was applied. Thus selecting for the favorable alleles of these markers could reduce the possible negative side-effects of growth promotants on tenderness.

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Cattle shortly after being placed on feed

Heavy-weight steers 1 week after terminal implant

References

Casas, E., S. N. White, T. L. Wheeler, S. D. Shackelford, M. Koohmaraie, D. G. Riley, C. C. Jr. Chase, D. D. Johnson, and T. P. L. Smith. 2006. Effects of calpastatin and μ-calpain markers in beef cattle on tenderness traits. J. Anim. Sci. 84:520-525.

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