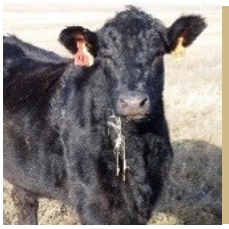

Examining Marker-assisted Management as a Strategy in Precision Agriculture to Maximize Carcass Traits in Beef Cattle

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We are looking to assess how different implant strategies interact with the GALR2 genotype to affect carcass traits as a means of better understanding the biological mechanisms influencing differences in muscle and fat growth. Our ultimate goal for this research is to develop marker assisted management strategies utilizing the GALR2 genotype to improve production efficiency and carcass characteristics in finishing cattle. Cattle on the study were selected from the Central Grasslands Research Extension Center cow herd based on specific genomic markers and fed at the North Dakota State University, Beef Cattle Research Complex and will be harvested during mid-May, early June 2019. At harvest carcass data including, hot carcass weight, ribeye area, back fat, yield grade, quality grade and marbling score, will be collected. The strip loin of each animal will be collected at harvest and brought to NDSU for further meat quality analysis including shear force, ether extract values, meat color, cook loss and pH to determine if any effects on meat quality can be attributed to genotypic differences.

Introduction

Marker-assisted management has become a growing practice in many successful feedlot production systems by assisting in identifying more efficient and profitable cattle. Feedlots have the opportunity to capitalize on increased profit margins by producing more uniform body composition of feeder cattle. Regardless of whether cattle are marketed on a live weight, carcass weight or grid basis, increased muscling and marbling are key to increasing profit for product. It is because of these market incentives with this study we are looking into the effects of a target for genetic marker assisted management on finishing cattle production.

In addition, value-based markets provide a premium price for well marbled carcasses. These are the reasons that marker-assisted management has become a growing practice in many successful feedlot production systems. There is an opportunity cost of underfed animals when uniform pen weights are not achieved (Woronuk et al., 2012). The North American beef industry provides premiums for well-marbled carcasses without excessive fat cover (DiCostanzo and Dahlen, 2000). These market incentives are the reason why with this study we are looking into the effects of a target for genetic marker-assisted management on finishing cattle production.

Galanin receptor 2 (GALR2) is a neuropeptide receptor that is associated with feeding behavior, insulin release, and growth hormone secretion (Smith et al., 1997; Waters and Krause,2000). A previous study in cattle examined the effect of a mutation in GALR2 (GALR2c.-199T>G) on carcass characteristics (Duncombe et al., unpublished). The GG genotype was associated with greater rib-eye area, whereas the TT genotype was associated with increased marbling score. This divergence in muscle and fat growth between the genotypes presents a unique opportunity for marker-assisted management.

Utilizing different management practices based on genotype, such as conservative versus aggressive implant strategies, could improve carcass uniformity and therefore, profitability, for beef producers. Additionally, gaining insight into the biology and mechanisms of how the GALR2 genotype affects muscle growth and fat deposition can point toward additional management strategies that could be implemented to improve beef production. Previous research demonstrated that the GALR2 genotype affects rib-eye area and marbling of cattle. An inverse relationship exists between muscle growth and fat deposition, with the GG genotype resulting in greater rib-eye area, but the TT genotype having a greater marbling score, with TG being intermediate.

The goal of this research is to study the underlying mechanism of how the GALR2 affects muscle and fat growth. This will support our ultimate goal of developing a marker-assisted management strategy, utilizing different implant strategies depending upon the GALR2 genotype to maximize rib-eye area and marbling while improving carcass uniformity.

Marker-assisted management is the concept of genotyping cattle for a genetic marker and employing different management practices based on genotype to improve production outcomes.

An example of this is a mutation in the gene leptin (LEPc.73C>T). Leptin is a hormone that affects the appetite pathway. Cattle with of the leptin TT genotype have increased body weight, back fat and marbling, compared with CC cattle (Kononoff et al., 2005; Woronuck et al., 2012).

A commercial test is available for cattle, which some commercial feedlots use to sort their cattle based upon genotype. To improve carcass uniformity each genotype is finished with a different number of days on feed, with CC cattle being fed for more days to reach the same degree of finish as TT cattle. This improved uniformity improves profitability and reduces inefficiencies caused by over- or under-finishing.

Galanin is a neuropeptide that is involved in appetite regulation and insulin secretion (Lang et al., 2007). Galanin acts through binding to the receptor GALR2, which is widely expressed throughout the nervous system and in other tissues including the kidneys and lungs (Waters and Krause, 2000). This large tissue distribution and association with feeding behavior make GALR2 a promising candidate gene for carcass traits in beef cattle. In

Table 1. The effect of GALR2 genotype on marbling score and back fat thickness in implanted and non-implanted beef steers.

	Marbling Score		Back Fat (mm)	
Genotype	GG	TT/TG	GG	TT/TG
Implanted	378.3[a]	397.8[b]	7.3[a]	8.4[b]
Non-implanted	430.9[a]	463.5[b]	9.1[a]	10.2[b]

previous research (Duncombe et al., unpublished) a mutation in GALR2 (GALR2c.-199T>G) has been found to be associated with differences in rib-eye area and fat deposition in beef cattle. Treatments were designed with 1000 implanted steers and 1000 non-implanted steers finished in a commercial feedlot. In implanted steers, the GG genotype was associated with significantly (P <0.01) greater rib-eye area than TT steers, with TG being intermediate (TT = 83.74, TG = 84.32 and GG = 86.90 centimeters^2). Conversely, there was no difference in rib-eye area in the non-implanted steers. Effects of the GALR2 genotype were observed in implanted and non-implanted steers for marbling score and back fat thickness. Steers of the GG genotype had significantly (P < 0.01) less back fat and lower marbling score than the TT and TG genotypes (Table 1). These results suggests that implant strategy had potential as a marker assisted management tool, with the GALR2 genotype to target rib-eye area in finishing cattle.

Procedures

Materials and Methods

All steer calves were selected from the Central Grasslands Research Extension Center beef cow herd based on genomics and arrived at the Beef Cattle Research Complex by Nov. 8th, 2018. Each steer was given time to train up to Insentec feeding systems. Of the 96 steers brought to the BCRC 94 began on the study starting Nov. 20, 2018 which was classified as day zero. Treatments were equally distributed across pens. The steer calves were allocated randomly to one of two implant strategies: one implant vs two implant. The implant strategies are: 1) Revalor-S (Merk Animal Health, Summit, NJ) on d 77 of finishing (1X) or 2) Revalor-S on d zero and d 77 of finishing (2X). Forty-seven of the steers were assigned randomly to the two implant strategy as illustrated in Table 2.

The cattle are being fed a standard feedlot ration and are projected to finish to a final body weight of approximately 1,400 pounds. Two weeks prior to slaughter, a muscle biopsy will be collected from the ribeye (longissimus muscle) of each steer. The procedure has been performed successfully on feedlot cattle in our lab in previous research with no adverse effects. The area will be surgically prepared (shaved and scrubbed) and a local anesthetic will be injected to numb the area. A small (approximately 1 inch) incision will be made through the skin and a muscle biopsy will be collected using a 10 millimeter Bergstrom biopsy needle. The biopsy will be preserved in RNA later. The incision will be sutured and injections of an antibiotic and a pain reliever will be administered.

The biopsies will be used to measure the expression of genes involved in muscle growth and fat deposition. RNA will be extracted and then reverse transcribed to cDNA. Gene expression will be measured via qPCR using SYBR green chemistry.

All steers are being weighed to track average daily gain, and blood samples are being collected every 28 days. The calves are projected to be finished on approximately a 180-day schedule with two separate slaughter dates due to the wide spread weight distribution at weaning and logistics of travel to the slaughter facility. Carcass data, including hot carcass weight, ribeye area, back fat, yield grade, quality grade and marbling score, will be collected at the slaughter plant. The strip loin will be purchased for further analysis of meat quality including shear force, ether extract values, meat color, cook loss and pH to determine if any effects on meat quality can be attributed to genotypic differences.

Table 2. Genotype and implant distribution by pen.

	Pen 1			Pen 2			Pen 3			Pen 4		
Implant Strategy	GG	TG	TT	GG	TG	TT	GG	TG	TT	GG	TG	TT
1 -Implant	1	6	5	3	5	5	2	3	5	4	4	2
2-Implants	3	3	5	2	5	4	3	6	4	1	5	7

Statistical Analysis

Treatment assignment is a completely randomized designed with a 3x2 factorial as displayed in Table 2. Genotype and implant strategy act as fixed effects while pen and slaughter date are considered random effects. Significance will be set at $P < 0.05$.

Results and Discussion

Cattle are currently on study, slaughter dates are projected for mid -May and early June. The long-term goal of this research is to develop marker-assisted management strategies utilizing the GALR2 genotype to improve production efficiency and carcass characteristics in finishing cattle. The immediate objective of this project is to determine how different implant strategies interact with the GALR2 genotype to affect carcass traits and better understand the biological mechanisms influencing differences in muscle and fat growth.

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Week two of study steer calves eating from Insentec Feeding System.