EFFECT OF LEPTIN GENOTYPE AND ZILPATEROL HYDROCHLORIDE ADMINISTRATION ON THE CARCASS CHARACTERISTICS OF FINISHING STEERS

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Abstract - Steers (n = 960; initial BW = 480.2 ± 35.3 kg) sorted into three leptin genotype (LG) groups (CC, CT, and TT) were allocated into 48 pens where half were fed zilpaterol hydrochloride (ZH) and the balance, a control ration. No LG x ZH interaction (*P* > 0.26) was detected for any carcass characteristic. Cattle from the TT group had greater (*P* < 0.01) marbling, subcutaneous fat depth, Canadian beef grading agency (CBGA) fat grade, and calculated empty body fat (EBF) than CC cattle. Moreover, TT cattle had reduced (*P* < 0.04) longissimus muscle area (LMA), CBGA muscle scores, and CBGA calculated lean than CC cattle. Cattle receiving ZH during the treatment period had increased (*P* < 0.01) HCW, dressed yield, LMA, CBGA longissimus width, CBGA longissimus length, and CBGA calculated lean. Additionally, cattle fed ZH exhibited decreased (*P* ≤ 0.01) EBF, marbling, fat depth, and CBGA fat grade. Antemortem sorting of cattle into LG's, could augment feeding management strategies and ultimately lead to increased marketing value of fed cattle.

Keywords- β-adrenergic agonist, Genetic Sorting

I. INTRODUCTION

Commercial utilization of genetic markers associated with various single nucleotide polymorphisms of the leptin gene in the fed cattle population of North America have been identified as a method for producers to increase value into the beef system (DeVuyst *et al.* [1]). Initially, the leptin gene was identified as a hormone product of the obese gene by Zhang *et al.* [2], furthermore Woods *et al.* [3] postulated that the gene may be an important factor in regulation of lipids and nutritive signaling in mammals. Recent investigations have suggested the sorting and selection of fed cattle based on the cytosine to thymine mutation (where CC = homozygous normal, CT = heterozygous, and TT = homozygous mutant) of the bovine leptin gene (Nkrumah *et al.* [4]). Nkrumah *et al.* [5] reported that cattle of the TT genotype had higher serum leptin concentration and more subcutaneous (SC) fat than other genotypes. Results of Kononoff *et al.* [6] indicated that TT genotype carcasses graded AAA more often than other genotypes with subsequently fewer yield grade 1 carcasses.

Zilpaterol hydrochloride (ZH) was approved for use in fed cattle operations in South Africa, Mexico, the United States, and Canada in 1997, 1999, 2006, and 2009 respectively (Delmore *et al.* [7]. Commercially available as Zilmax® (Merck Animal Health, Summit, NJ, U.S.A.), investigations of the feed additive ZH in fed cattle have indicated greater hot carcass weight (HCW), dressed yield, and longissimus muscle area (LMA) when compared to animals not receiving the beta-adrenergic agonist (Avendano-Reyes *et al.* [8], Elam *et al.* [9], Lawrence *et al.* [10]). The objective of this study was to determine if differing leptin genotypes (CC, CT, or TT) resulted in similar response to zilpaterol hydrochloride feeding.

II. MATERIALS AND METHODS

The feeding portion of this experiment was conducted at Cattleland Feedyard (Strathmore, AB). All experimental procedures followed the guidelines described in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 1999).

Initial Processing. Ear tissue samples were collected from candidate steers and genotyped by Quantum Genetics (Saskatoon, SK). Steers were vaccinated against bovine rhinotracheitis virus, bovine viral diarrhea virus (Types 1 and 2), parainfluenza-3 virus, and bovine respiratory syncytial virus, treated for internal and external parasites and implanted with 40 mg estradiol and 200 mg trenbolone acetate.

Treatment Structure. Prior to assignment to the research pens, and subsequent to the genotype determination of the candidate animals, the steers were individually weighed and ranked by weight within each genotype. The heaviest 40 steers in each LG group were assigned to block 1, the next 40 heaviest in each leptin genotype were assigned to block 2; this process was continued until the remaining 6 blocks were filled. Within a block, the 40 steers in each leptin genotype group were randomly assigned to ZH feeding for 0 or 20 days followed by a 4 day withdrawal prior to harvest. After treatment assignment, steers were individually tagged to treatment and allocated to the research pens. Each pen group was weighed on a pen scale prior to the initial feeding to obtain a trial starting weight. The experimental design structure was a randomized complete block design; the treatment structure was a 3 x 2 factorial arrangement consisting of 3 genotypes assigned to 0 or 20 d ZH feeding. The six treatment groups were assigned to 8 blocks of steers for a total of 48 pens (n=960 head).

Zilpaterol Administration. Within a block, ZH administration (for those pens assigned zilpaterol) began on a common day. Prior to feeding, on the morning ZH administration began, each pen within a block was weighed on a pen scale to obtain a starting weight for the ZH phase of the feeding period.

Feeding Management. All animals were “stepped up” to a final total mixed ration and permitted *ad libitum* consumption. The final finishing ration met or exceeded NRC [11] requirements and contained monensin (~33 g/ton 90% DM basis; Rumensin, Elanco Animal Health) and tylosin (~10 g/ton on a 90% DM basis; Tylan, Elanco Animal Health). For those pens receiving ZH for 20d, the ration contained 8.3 g/ton on a 100% DM basis. A 4 day withdrawal was observed for ZH fed cattle.

Carcass evaluation. Each pen was weighed on a pen scale the day of shipping to obtain a final weight for the trial. All cattle within a block were harvested on the same day at XL Foods Inc., Brooks, AB. Carcasses were evaluated according to CBGA (1998) standards by the West Texas A&M University - Beef Carcass Research Center.

Statistical Analysis. Measured carcass data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC); the model included the fixed effects of LG, ZH feeding, and the ZH x LG interaction while block served as a random effect. Means were calculated via the LSMEANS option and separated when significant ($\alpha = 0.05$) using the PDIFF option.

III. RESULTS AND DISCUSSION

Carcass Characteristics. No ZH x LG interactions occurred ($P > 0.26$) for any carcass performance variable included in this analysis (Table 1). No differences ($P > 0.14$) were found among LG groups for dressed yield, CBGA yield grade, or CBGA longissimus width (dorsal-ventral). Carcass measures that tended to be different ($P < 0.10$) among LG groups included hot carcass weight and CBGA longissimus length (medial-lateral). Carcasses in the TT group had lower values for hot carcass weight and CBGA longissimus length than the CC group. Differences found ($P < 0.03$) amongst LG groups for longissimus muscle (LM) area indicated cattle in the TT group were smaller than cattle in the CC group. Marbling scores were also compared and found to be significant ($P < 0.01$) with cattle in the TT group having higher scores than cattle in the CT and CC groups.

Indicators of finish indicated cattle in the TT and CT groups had greater ($P < 0.05$) values for subcutaneous fat thickness, CBGA fat grade, empty body fat (%), as well as lower values for CBGA muscle score when compared to the CC group. Moreover, differences ($P < 0.01$) amongst LG groups indicated cattle in the TT group had lower CBGA calculated lean (%) than cattle of the CC genotype.

Table 1. Effect of leptin genotype on carcass characteristics

	Leptin genotype				P-value
Item	CC	CT	TT	SEM	LG
Pens	16	16	16	-	-
Animals	319	316	320	-	-
Hot carcass weight, kg	350.8	351.1	347.3	3.6	0.07
Carcass yield	58.98	59.07	58.70	0.14	0.17
Longissimus muscle area, cm^2	91.14^z	89.76^{yz}	88.35^y	0.64	*0.02*
Marbling score	376^y	383^y	391^z	4	*<0.01*
Fat depth, cm	0.83^y	0.91^z	0.96^z	0.04	*<0.01*
Empty body fat, %[a]	26.21^y	26.71^z	27.01^z	0.24	*<0.01*
CBGA yield grade	1.26	1.28	1.31	0.06	0.71
CBGA fat grade	2.83^y	3.06^z	3.24^z	0.08	*<0.01*
CBGA Longissimus width	1.82	1.77	1.69	0.04	0.14
CBGA Longissimus length	2.52	2.42	2.41	0.04	0.09
CBGA muscle score	2.40^z	2.25^{yz}	2.19^y	0.06	*0.04*
CBGA lean, %	60.93^z	60.44^y	60.06^y	0.14	*<0.01*

[a] Empty body fat, % = 17.76207 + (4.68142 x s.c. fat thickness, cm) + (0.01945 x HCW, kg) + (0.81855 x quality grade) – (0.06754 x LM area, cm^2). Numerical quality grade values were assigned based on the marbling score derived quality grade such that Standard = 3 to 4; Select = 4 to 5; low Choice = 5 to 6; average Choice = 6 to 7; high Choice = 7 to 8; low Prime = 8 to 9; and average Prime = 9 to 10; Guiroy et al. (2002); ^{y,z}Means with different superscripts differ ($P \leq 0.05$)

Comparing these results to previous literature, Nkrumah *et al.* [4] found no differences amongst LG groups when comparing marbling and LM area. Nevertheless, more recent investigations have found differences among LG's when comparing marbling score, in which cattle of the TT genotype had greater values than any other genotype (Nkrumah *et al.* [5]). When comparing data indicating physiological finish, the previous literature indicates that cattle of the TT genotype have increased fat depth, lower yield grade, and lower lean yield than other LG groups. These differences amongst genotypes suggest that producers may be able to segregate cattle of a known LG SNP's and adjust the time allotted to reach industry standard finishing endpoints.

Comparing cattle fed ZH for 0 and 20 d, cattle in the ZH treatment group had greater (P < 0.01) values for hot carcass weight, dressed yield (%), LM area, CBGA longissimus width, CBGA longissimus length, CBGA muscle score, and CBGA calculated lean (%). Furthermore, cattle fed ZH had lower (P < 0.02) values for marbling score, subcutaneous fat thickness (fat depth), and CBGA fat grade, with CBGA yield grade not being significant (P = 0.37). These results support earlier investigations of the use of ZH in the fed cattle populations with increased values for indicators of muscling and subsequent reductions in marbling as well as fat depth indicators (Avendano-Reyes *et al.* [8], Elam *et al.* [9]).

Table 2. Effect of zilpaterol on carcass characteristics

	Zilpaterol			P-value
Item	No	Yes	SEM	ZH
Pens	24	24	-	-
Animals	479	476	-	-
Hot carcass weight, kg	340.9	358.6	3.5	*<0.01*
Dressed yield	57.93	59.90	0.11	*<0.01*
Longissimus muscle area, cm^2	85.86	93.64	0.52	*<0.01*
Marbling score	392	374	4	*<0.01*
Fat thickness, cm	0.94	0.87	0.03	*0.01*
Empty body fat, %[d]	26.98	26.31	0.23	*<0.01*
CBGA yield grade	1.30	1.26	0.06	0.37
CBGA fat grade	3.17	2.92	0.07	*0.01*
CBGA Longissimus width[e]	1.61	1.91	0.04	*<0.01*
CBGA Longissimus length[f]	2.25	2.65	0.04	*<0.01*
CBGA muscle score	1.98	2.59	0.05	*<0.01*
CBGA lean, %	59.98	60.98	0.11	*<0.01*

[a] Empty body fat, % = 17.76207 + (4.68142 x s.c. fat thickness, cm) + (0.01945 x HCW, kg) + (0.81855 x quality grade) – (0.06754 x LM area, cm^2). Numerical quality grade values were assigned based on the marbling score derived quality grade such that Standard = 3 to 4; Select = 4 to 5; low Choice = 5 to 6; average Choice = 6 to 7; high Choice = 7 to 8; low Prime = 8 to 9; and average Prime = 9 to 10; Guiroy et al. (2002); ^{y,z}Means with different superscripts differ ($P \leq 0.05$)

IV. CONCLUSION

This investigation indicated that the sorting of fed cattle into one of three LG's resulted in differences related to carcass performance. Beef producers who sell carcasses via a value-based system may be able to increase profitability by utilizing the information related to factors that are typically recognized as indicators of physiological finish. Therefore, cattle determined to be of the TT genotype may have an earlier marketing endpoint than cattle of other leptin genotypes. Furthermore, the utilization of ZH in fed cattle operations may further enhance profitability through increases in feeding and carcass performance measures which were exhibited by all LG groups investigated. This study postulates that the combined effects of sorting cattle for LG and feeding ZH could be a positive influence in the beef marketing channel.

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