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SERUM HORMONE CONCENTRATIONS AS PREDICTORS OF CARCASS COMPOSTION IN A RANDOM ALLOTMENT OF AMERICAN FED BEEF CATTLE

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Introduction

The U. S. beef industry continues to struggle to better understand the latter part of the finishing phase and the changes that occur within the animals in the weeks prior to harvest. Feeding cattle to a desired United States Department of Agriculture (USDA) quality grade may appear to be quite easy, though maximizing performance (Feed/Gain) and minimizing excess 12th rib back-fat and subsequent increase in USDA yield grade (YG) during the last 60 days of feeding remains a challenge. The protein hormone leptin was discovered by Zhang et al. (1994) in the mouse model. Leptin is primarily secreted from white adipocytes with the task of regulating food intake, energy expenditure, and energy balance within the body (Houseknecht et al., 1998). Most important to the meat animal industry is the relationships that have been discovered between leptin and carcass merit. Serum leptin correlations have been reported by Minton et al. (1998) and Geary et al. (2003) with 12th rib back fat, USDA yield grade, marbling scores, kidney, pelvic and heart fat (KPH) and ultimately USDA quality grade in beef cattle. McFadin et al. (2003) reported positive correlations between serum leptin and 12th rib back fat, USDA yield grade and marbling score. The results of these trials tempt us to conclude that circulating serum leptin concentrations could be used as a means to predict beef carcass merit prior to harvest. At the same time, bovine growth hormone (bGH) and insulin-like growth factor-I (IGF-I) are well documented as endocrinological links to lean muscle deposition. Trenkle and Topel (1978) reported correlations between bGH, percent carcass fat and percent carcass muscle while Anderson et al. (1988) reported similar correlations between muscle and adipose tissue deposits with both bGH and IGF-I. This research has analyzed the correlations between leptin, bGH, IGF-I and carcass parameters in a random allotment of steers and heifers harvested through an American commercial harvest facility.

Objectives

The objectives of this project were to determine if correlations are present between leptin, insulin-like growth factor-I, bovine growth hormone and beef quality parameters in a random allotment of beef market animals.

Methodology

Animals were selected from the harvest line through the Emporia, Kansas Tyson Fresh Meats facility on 4 separate random collection (RC) days. Collection days are detailed in Table 1. The animals were from a variety of management strategies and were transported varying distances to the commercial harvest facility. Animals were randomly chosen from the bleed chain. No pre-harvest information was gathered prior to initiation on the project.

Table 1. Summary of days* in which random sampling occurred at the Emporia, Kansas Tyson Fresh Meats Facility

Variable	RCI	RCII	RCIII	RCIV
Date Sampled	3/30/2004	5/17/2004	8/17/2004	1/03/2005
Low Temperature, C	1.67	16.67	20.00	-1.67
High Temperature, C	11.67	27.22	32.78	1.11
Heifers	22	227	348	160
Steers	176	299	185	335

*Source: National Climatic Data Center, Washington, D.C. USA

Blood samples were collected at exsanguination and were allowed to clot for approximately 24 h at 4° C. Prior to centrifugation of the samples, caps were removed and tubes were reamed with wooden stir rods to aid in serum separation. Samples were centrifuged at 2,500 X g for 45 min. Serum was pipetted off, placed in 48 well plates (5 mL/well), and stored at -20° C until analysis. Leptin concentrations were determined by a double-antibody leptin radioimmunoassay as described by Delavaud et al. (2000). IGF-I and bovine growth hormone (bGH) concentrations were assayed as described by Lalman et al. (2000).

Hot carcass weight and packer number were recorded prior to being chilled at 2° C for 24 h. After 24 h chill, the carcasses were ribbed and the $12^{th}/13^{th}$ rib interface was exposed and allowed to bloom prior to obtaining skeletal maturity and marbling score. Carcasses were analyzed by trained evaluators from the University of Missouri. Ribeye area was determined using the reverse blot image technique described by Martin (1991). The reverse longissimus dorsi (LD) images obtained on the filter papers were analyzed at the University of Missouri by tracing the LD image outline with a pencil. The area was then determined through the use of a beef ribeye area dot grid (Martin, 1991).

Fat thickness was recorded on the bloom chain using a USDA preliminary yield grade ruler (USDA, 1997) at an anatomical location perpendicular to the vertebral column and ¾ the distance, caudal the ribeye muscle. The preliminary yield grades were adjusted, correcting for atypical fat distribution and/or defects. Percentage of kidney-pelvic-heart (KPH) fat was estimated. Marbling scores were determined by a trained evaluator from the University of Missouri. To minimize variation, the same evaluator determined marbling scores and maturity on RCII, III and IV animals. Animals within RCI were analyzed by a separate member of the University of Missouri carcass collection group. Both graders were standardized to marbling scores based on the USDA marbling standards (USDA, 1997; Abundant, Moderately Abundant, Slightly Abundant, Moderate, Modest, Small, Slight, Traces, and Practically Devoid). Maturity scores were recorded if

identified outside of "A" maturity based on the USDA maturity classification standards (USDA, 1997). Dark cutters were also documented based on percentage of LD determined to be dark.

Statistics. The GLM procedure of SAS (SAS Inst. Inc., Cary, NC) was utilized to test for differences between random collection days. Endocrine hormone and carcass parameters were used within the model as dependent variables while kill day and sex of the animals were independent variables. For the complete data set, relationships between serum endocrine concentrations (Leptin, IGF-I and bGH) and carcass traits were quantified by Pearson correlation coefficients and linear regression.

Results & Discussion

Table 2. Least squares means (SEM)[a] for leptin, IGF-I, bGH and carcass traits in randomly selected cattle

Variable	RCI		RCII		RCIII		RCIV	
Leptin, ng/mL	12.71^{ef}	(0.59)	8.86^{d}	(0.23)	13.71^{f}	(0.24)	10.27^{e}	(0.25)
IGF-I, ng/mL	17.78^{g}	(0.58)	15.03^{f}	(0.22)	11.53^{d}	(0.23)	13.08^{e}	(0.24)
GH, ng/mL	33.65^{e}	(3.72)	41.78^{f}	(1.45)	24.85^{d}	(1.49)	54.52^{g}	(1.61)
Hot Carcass Weight, kg	330.49^{d}	(4.50)	329.31^{d}	(1.75)	348.05^{e}	(1.81)	360.37^{f}	(1.91)
Marbling Score [b]	42.07^{de}	(0.98)	41.00^{d}	(0.38)	42.87^{ef}	(0.39)	44.02^{f}	(0.42)
Fat depth, cm [c]	1.17^{de}	(0.06)	1.10^{d}	(0.02)	1.29^{e}	(0.02)	1.22^{ef}	(0.02)
Kidney-pelvic-heart fat %	2.22^{d}	(0.05)	2.77^{f}	(0.02)	2.62^{e}	(0.02)	2.26^{d}	(0.02)
Ribeye area, cm^2	85.67^{ef}	(1.26)	83.58^{de}	(0.49)	85.48^{f}	(0.51)	82.92^{d}	(0.54)
Calculated Yield Grade	2.61^{d}	(0.09)	2.76^{d}	(0.04)	2.98^{e}	(0.04)	3.07^{e}	(0.04)

[a] (SEM) is the standard error of the least squares means.

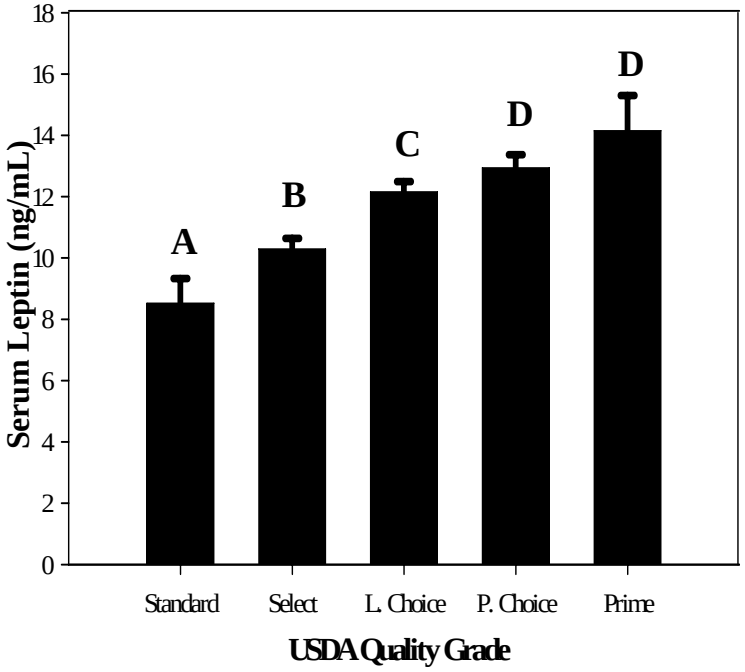
[b] Mean marbling scores were derived from scores assigned based on a scale in which: 10 – 19 = Practically Devoid (PD), 20 – 29 = Traces, 30 – 39 = Slight, 40 – 49 = Small, 50 – 59 = Modest, 60 – 69 = Moderate, 70 – 79 = Slightly Abundant, 80 – 89 = Moderately Abundant and 90 – 99 = Abundant.

[c] Back fat measurement taken at 12/13th rib interface.

[d,e,f,g] Means within a row lacking a common superscript letter differ ($P < 0.05$).

Specifics about animals within each random collection are described in Table 2. When steers and heifers were separated by kill day, serum leptin concentrations were inconsistent. Within RCI and RCIV, heifers had higher ($P < 0.05$) leptin concentrations than steers, though within RC II and RCIII the opposite was true. Heifers had lower ($P < 0.05$) serum IGF-I concentrations, were fatter ($P < 0.05$) at the 12th rib and had lighter ($P < 0.05$) weight carcasses than their castrated male counterparts. Correlations between serum leptin and carcass parameters within this project agree with findings of Minton et al. (1998), Geary et al. (2003) and McFadin et al. (2003). In the present study serum leptin concentrations were correlated ($P < 0.01$) with 12th rib fat depth ($r = 0.37$), USDA yield grade ($r = 0.32$), marbling score ($r = 0.28$) and kidney-pelvic-heart fat ($r = 0.23$). Trenkle and Topel (1978) found correlations between bGH percentage of lean muscle mass while Anderson et al. (1988) reported correlations with both IGF-I and bGH with adipose and lean muscle percentages. Within this project, bGH was correlated ($P < 0.01$)

Figure 1. Least squares means for serum leptin by USDA Quality Grade



A,B,C,D Means lacking a common superscript differ ($P < 0.05$)

to KPH ($r = -0.24$), 12th rib back fat ($r = -0.16$) and USDA yield grade ($r = -0.11$). Insulin-like growth factor I was correlated ($P < 0.01$) with 12th rib back fat ($r = -0.23$), KPH ($r = -0.20$), marbling score ($r = -0.20$), USDA yield grade ($r = -0.17$), and sex of the animals surveyed ($r = 0.47$) with heifers consistently lower in serum concentration than steers.

Correlations existed between the endocrine hormones within the present study. Leptin was correlated to both IGF-I ($r = -0.11$; $P < 0.01$) and bGH ($r = -0.31$; $P < 0.01$) while IGF-I was correlated to bGH ($r = 0.16$; $P < 0.01$).

Figure 1 shows least squares means of serum leptin concentrations when comparing USDA quality grade from lowest to highest; standard, select, low choice, premium choice, and prime carcasses, respectively. When analyzing the least squares means of serum leptin concentrations and USDA Yield Grade, yield grade 1 animals had the lowest serum leptin concentration (8.11 ng/mL) and differed from yield grade 2 animals ($P < 0.05$). Yield grade 2 carcasses were lower (9.80 ng/mL) than yield grade 3 animals (12.43 ng/mL) though yield grade 3, 4 and 5 animals did not differ ($P > 0.05$) in their serum leptin concentrations.

Conclusions

This project has shown that distinct, separable circulating leptin differences exist between USDA quality grades for a random allotment of young American beef cattle. Furthermore, endocrine hormone concentrations, including leptin, IGF-I and bGH, can be correlated with carcass parameters in randomly selected cattle despite varying management and nutritional regimes though leptin appears to be the best indicator of quality parameters. The ability to segregate live animals based on leptin concentrations and establish correlations with marbling score could be quite beneficial to producers marketing their animals on a carcass merit system based on higher USDA quality grades. This research shows that animals within quality grades up to the premium choice category can be segregated from each other through the use of serum leptin concentration. If determined pre-harvest, the premiums associated with choice and prime

carcasses could have a substantial impact on beef producer's economic return. A rapid determinant of serum leptin concentration does not exist today, therefore future research must continue in an attempt to develop a producer friendly means of determination.

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