Relationship between serum concentrations of leptin and carcass composition and quality in beef cattle and swine.

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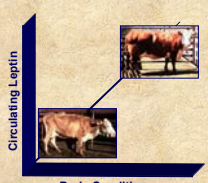
OBJECTIVE:

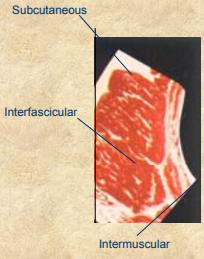
To determine the relationship between serum concentrations of the protein hormone leptin with growth and carcass traits in feeder cattle and swine.

ABSTRACT:

The protein hormone product of the ob gene, leptin, has been implicated in the control of food intake and body composition. The principal site of leptin production is the adipocyte, and circulating concentrations of leptin have been positively correlated with body fat mass in humans and rodents, with limited data available in other species. Recently, four investigations were conducted to evaluate the relationship between circulating concentrations of leptin and carcass composition and quality in beef cattle and swine. Our objectives were to determine if circulating levels of leptin were indicative of beef and pork carcass quality and composition and to determine the composition and quality factors which significantly correlated with serum levels of leptin. The beef studies consisted of 3 investigations. Two of the studies were conducted at Miles City, MT with two groups of crossbred steers and heifers managed under feedlot conditions. The first group (Beef 1), consisted of 88 ½Red Angus, ¼Charolais, and ¼Tarentaise composite steers and the second group (Beef 2), consisted of 91 F2 steers and heifers born to Limousin, Hereford, or Piedmontese by Beef 2 F1 cows crossed to F1 bulls of similar genetic makeup. Beef 1 and Beef 2 cattle were harvested between 14 and 17 months of age with an average hot carcass weight (HCW) of 293.9 and 276.9 ± 3.4 kg, respectively. A third group of cattle in this investigation consisted of steers (average HCW = 343.9 ± 3.6 kg) entered into the 2001 Missouri State Beef carcass contest (Beef 3), which represented various genotypes, raised under diverse management conditions. The swine study consisted of single survey of 310 barrows and gilts entered in the 2000 National Barrow Show Sire Progeny Test (Pork 1). Breeds were Berkshire (n = 138), Chester White (n = 37), Duroc (n = 40), Landrace (n = 27), Poland China (n = 26), and Yorkshire (n = 42). Serum samples were collected from pigs upon entry on test (approximately 34 kg BW) and again 24 h prior to harvest (approximately 111 kg BW). Serum concentrations of leptin from cattle and swine were determined using a heterologous leptin radioimmunoassay validated for use in these and other species in our lab. All beef and pork carcass data measurements were collected by trained personnel. Serum concentrations of leptin at harvest were significantly correlated with subcutaneous back fat thickness ($r = 0.34$ to 0.51; $P < 0.01$) and marbling score ($r = 0.10$ to 0.50; $P < 0.06$) across all four studies. In Beef 2 and Pork 1, circulating concentrations of leptin were negatively correlated with ribeye area ($r = -0.45$ and -0.30, respectively; $P < 0.001$) however, this relationship did not exist in either Beef 1 or Beef 3. In Beef 1 and Beef 2, kidney, pelvic, and heart scores were significantly correlated with serum concentrations of leptin ($r = 0.42$ and 0.56; $P < 0.001$) however, this relationship was not found to exist in the Beef 3 investigation. In Beef 1, Beef 2, and Beef 3, carcass yield grade was associated with leptin ($r = 0.19$, 0.52, and 0.19, respectively; $P < 0.10$). In Pork 1, Berkshire pigs had greater serum concentrations of leptin (6.93 ng/ml) than all breeds ($P < 0.05$) except Poland China (6.80 ng/ml) at harvest. Barrows had greater serum concentrations of leptin than did gilts (6.83 and 3.71 ng/ml; $P < 0.001$). Further research is necessary to determine if leptin may be used in conjunction with other measurements to predict live animal carcass composition.



In many species including cattle, sheep, swine, horses and humans, leptin concentrations increase as subcutaneous fat increases.



INTRODUCTION:

Leptin

Leptin is produced almost exclusively by adipocytes and has been implicated in the control of energy expenditure and food intake, thus influencing body composition in mammals.

Adipocytes

The physical and chemical nature of adipocytes may influence leptin synthesis and secretion because as adipocytes increase in mass and diameter, more leptin mRNA is synthesized (Auwerx and Staels, 1998; Casanueva and Dieguez, 1999).

Adipocytes are thought to develop from fibroblast-like cells called adipoblasts. The first adipocyte depot to be formed is in the visceral area. If nutrients are available, then fat is then deposited subcutaneously and then deposited between the muscles (intermuscular) followed by deposition within the muscles (interfascicular) (Hedrick et al., 1994).

Accrual of adipose tissue in the body is a result of hyperplastic adipocyte growth followed by hypertrophic changes (Owens et al., 1993). Hypertrophy of adipose tissue is the major mechanism involved in finishing animals to market weight (Hood, 1982) and as the animal matures, most growth is in the form of adipose tissue.

Adipocyte diameter varies according to tissue location. For example, in a study of 17-month-old crossbred steers, diameter of adipocytes were classified in the following regions as containing the largest to smallest adipocytes: KPH, mesenteric, subcutaneous, intermuscular, intramuscular, and brisket fat (Cianzio et al., 1985).

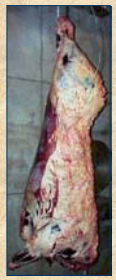
RESEARCH PROCEDURES:

Beef 1
Animals: 88 Steers (⅛ Red Angus, ¼ Charolais, and ¼ Tarentaise)
Blood Sample: Collected via coccygeal venipuncture 24 hours prior to harvest.
Harvest: Greely, CO

Beef 2
Animals: 91 Steers and Heifers (born to Limousin, Hereford, or Piedmontese by Beef 1 type bulls).
Blood Sample: 3 days prior to harvest via coccygeal venipuncture and then at harvest. Average mean leptin concentration was used.
Harvest: Miles City, MT

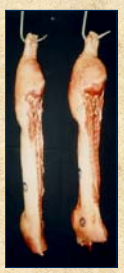
Beef 3
Animals: 84 steers of various genotypes and managed under various management conditions obtained from the 2001 Missouri State Fair.
Blood Sample: Obtained at harvest
Harvest: Emporia, KS

Pork 1
Animals: Berkshire (n=131), Chester White (n=33), Duroc (n=40), Landrace (n=23), Poland China (n=26), and Yorkshire (n=41) gilts and barrows entered in the 2000 National Barrow Show Sire Progeny Test, New Hampton, IA.
Blood Sample: Obtained 24 hours prior to harvest via jugular venipuncture.
Harvest: Austin, MN



Blood Handling Procedures:
All blood samples were allowed to clot for 6 to 24 hours at 4°C followed by centrifugation at 2,500 x g for 30 min. Serum was harvested and stored at -20°C until Leptin analysis as described by Delavaud et al., 2000.

Animal Harvesting:
All animals were harvested according to the Humane Slaughter Act of 1978.



Carcass Data Collection:

Beef: Carcasses were chilled at 2°C for 24 h and ribbed between the 12th and 13th ribs according to USDA 1989 guidelines.

Pork: Hot carcass weight, carcass length, and last rib backfat thickness was taken on line approximately post-harvest. Following 24 hour chill, remaining carcass data were obtained.

Statistics:

Beef 1
General Linear Models of SAS (GLM) was used with carcass traits as dependent variables and serum concentrations of leptin as the independent variable. The relationship between serum concentrations of leptin and carcass traits were quantified using Pearson correlation coefficients and linear regression.

Beef 2
GLM was used with serum concentrations of leptin and carcass traits as dependent variables and breed, sex, time on finishing ration, and all possible interactions as independent variables. Partial correlations was used to determine the relationship between leptin and carcass traits

Beef 3
Relationships between serum concentrations of leptin and carcass traits were quantified by Pearson correlation coefficients using SAS.

Pork 1
Data was analyzed using SAS. Fixed effects of off-test date, breed and gender were evaluated for differences associated with off-test leptin, carcass composition and carcass quality parameters. Relationships between concentrations of leptin and carcass traits were quantified by Pearson correlation coefficients. Mean separation procedures were performed using the LSMEANS statement with the PDIFF option.

SUMMARY OF RESULTS

Variable	Study Group			
	Beef 1	Beef 2	Beef 3	Pork 1
	R value			
Hot carcass weight	0.14	-0.23*	0.16	0.05
Fat Depth	0.34**	0.46**	0.34**	0.51**
Marbling Score	0.35***	0.50***	0.26*	0.10†
KPH Fat	0.42***	0.56***	0.13	NA
Ribeye Area	0.12	-0.45***	0.11	-0.30***
Calculated yield grade	0.19†	0.52***	0.19†	NA
Dressing percent	0.21†	-0.31†	NA	-0.02

† $P < 0.10$; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

RESULTS:

Gender Differences:

Beef 1 and Beef 2

Leptin concentrations were similar between steers and heifers, however, steers appeared to have higher marbling scores and KPH weight.

Pork 1

Barrows had greater serum concentrations of leptin and greater 10th rib backfat with less muscle than gilts.

Beef 3

This study was composed of all steers of various breeds so comparisons could not be determined.

RESULTS:

Breed Differences:

Beef 1 and Beef 2

Trait	Beef 1	Beef 2
Leptin	18.7 ng/ml	27.0 ng/ml
Fat	0.76 cm	0.94 cm
Marbling	10.30	12.82

Pork 1
Berkshires had greater leptin concentration (6.58 ng/ml) than did all breeds but Poland China (6.45 ng/ml) and Landrace (4.77 ng/ml). Berkshire also had the lowest percentage of fat-free carcass lean (46.22%)

CONCLUSION:

Leptin is correlated to subcutaneous fat depth and marbling scores in feeder cattle and pigs.

Breeding, gender, and pre-harvest management will influence carcass traits and subsequent correlations with leptin concentration.

IMPLICATIONS:

As of now, there is no proven method for assessing carcass quality in live animals.

With the increase in alliances, a desire to know carcass quality data is increasing.

Producers are seeking a quick return on carcass quality data from the processors, the leptin assay could provide means to do this.

FUTURE?

Industry must set a premium for quality carcasses.

Producers must continue to improve the genetics behind market animals.

Research must find ways in which to determine carcass quality prior to slaughter and perhaps, prior to the finishing phase.

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