EFFECT OF SLAUGHTER DATE ON LONGISSIMUS MUSCLE COMPOSITION AND TENDERNESS FROM FEEDLOT STEERS

M.T. Van Koevering[1], H.G. Dolezal[2], D.R. Gill[3], and F.N. Owens[3]

Story in Brief

Two hundred and fifty-six (256) crossbred yearling steers initially weighing 329 kg were used to study the effect of slaughter date on tissue composition and tenderness. Steers were divided into four slaughter groups (64 steers) and fed for either 105, 119, 133 or 147 d. Plasma cholesterol concentrations (mg/dl) increased linearly across slaughter group. Cholesterol (mg/100g wet tissue) and total lipid content increased linearly within the longissimus muscle as time on feed increased. While the percentage of protein and moisture within the longissimus muscle decreased concurrently with time on feed. Cooking shrinkage and cooking time (min/100g raw tissue) decreased linearly across slaughter date. Tenderness of ribeye steaks tended to increase linearly with slaughter date; resulting in fewer steaks being considered tough. LM steaks from cattle fed greater than 119 d had significantly higher amounts of cholesterol, without significantly enhancing tenderness.

(Key Words: Feedlot Steers, Cholesterol, Tenderness.)

Introduction

The length of time cattle are fed a high concentrate diet is dependent primarily upon economics. Seasonal changes in feed and cattle costs dictate the length of time cattle are fed. Longer feeding periods for cattle of a given starting weight will increase final live weight, hot carcass weight, longissimus area, subcutaneous fat thickness, yield grade and quality grade (Zinn et al., 1970a; Hicks et al., 1987; Dolezal et al., 1982), only some of which increase the quality of cattle. Additional factors such as cholesterol content and tenderness of ribeye steaks may need to be included in determining carcass quality in the future. Tenderness increases with time to a point, after which animal age may have a greater influence. Thus, the objective of this study was

[1]Research Associate [2]Associate Professor [3]Regents Professor

to evaluate the effects of different slaughter dates on tissue composition and tenderness.

Materials and Methods

Two hundred and fifty-six crossbred steers (329 kg) were selected from a larger group (n=570) based on uniform size, weight and breed-type. Steers with greater than 25% Bos Indicus or Angus characteristics were removed, leaving steers of primarily British x Continental breed-type. Upon arrival, steers were individually weighed, identified, and blocked into 4 weight groups based on initial weight. Sixteen (16) steers from each weight group were randomly assigned to pens (8 steers/pen) and pens were assigned to specific slaughter dates. Eight pens (2 from each weight group) were assigned to be fed for a different number of days. Steers were fed for either 105, 119, 133 or 147 days after arrival. Plasma was obtained 16 h post-feeding in non-silicone coated Na_2EDTA tubes and stored at -20°C until analyzed. Cholesterol concentrations were determined using an enzymatic reaction.

A 20 cm thick section of the Longissimus Muscle (LM) corresponding to the 9 through 12th rib section was removed from the left side of each carcass; it was vacuum packaged, and shipped to the Oklahoma State University Meat Laboratory. LM sections were aged at 2°C for 14 d postmortem. Ribeye samples subsequently were frozen (-30°C) and faced (uneven portion removed from the posterior end) before being fabricated into steaks for determining composition. A 1.3 cm thick LM steak was removed from the posterior end of each LM section; it was denuded of exterior fat and epimysial connective tissue, and stored for proximate analysis. Immediately anterior to the steak used for proximate analysis, the remaining LM was cut into 2.5 cm thick steaks to be used for cholesterol analysis and shear force determination. Samples were prepared in duplicate for chemical analysis by immersing them in liquid nitrogen and powdering them in a Waring Commercial Blendor®. A frozen 3 g sample of powdered LM was subjected to proximate analysis according to procedures outlined by AOAC (1984). Cholesterol content was determined through a modification of Lepage and Roy (1986).

Cooking properties and shear force determinations were conducted as described in AMSA (1978). LM steaks used to determine shear force were thawed at 2°C for 24 h, trimmed of s.c. fat, weighed and broiled on a Faberware® open hearth broiler to a final internal temperature of 70°C. Cooking time to a medium degree of doneness (minutes/100 g raw steak) and cooking shrinkage (percentage weight loss) were calculated for each steak. Steaks were allowed to cool to 25°C, after which six cores (1.27 cm diameter) were removed parallel to the longitudinal direction of the muscle fibers. Cores then were individually sheared using a Instron® Model SD-50 Warner-Bratzler shear apparatus to determine the peak force required.

Beta-hydroxy-β-methyl butyrate (HMB), a metabolite of leucine, was imposed across this experiment to evaluate the effects of HMB on performance, carcass characteristics and tissue composition. Data were analyzed on a pen basis using least squares analysis with a linear model that included effects of HMB presence (df = 1), weight block (df = 3), slaughter date (df = 3) and all two way interactions being included in the model. Carcass data, chemical composition and shear force values of LM were regressed against the mean carcass weight and s.c. fat thickness. When a slope was significant, but the interaction was not significant, the adjusted means were reported . Least squares means were calculated and slaughter group means were compared using T-tests and linear, quadratic and cubic contrasts.

Results and Discussion

Table 1 illustrates the chemical composition of the LM. Cholesterol concentrations (mg/dL) in plasma increased linearly (L; P<.01) across slaughter group, with steers fed for 105 d having the lowest (P<.05)

Table 1. Effects of slaughter group on plasma cholesterol and longissimus muscle composition.[a]

	Days on Feed				
	105	119	133	147	SEM
No. Pens	8	8	8	8	
No. Steers	61	63	64	64	
Plasma:					
Cholesterol, mg/dL^{L}	96.55^{c}	118.15^{d}	115.74^{d}	123.67^{d}	4.05
Proximate Analysis, %					
Total Lipid^{L}	3.01^{b}	3.66^{c}	3.75^{c}	4.00^{c}	.18
Protein^{lQ}	22.70^{b}	22.44^{bc}	22.12^{c}	22.50^{bc}	.12
Moisture^{L}	73.64^{b}	73.23^{cd}	73.40^{bc}	72.97^{d}	.12
Cholesterol,^{L} mg/100g wet tissue	47.26^{b}	47.00^{b}	50.81^{c}	52.33^{c}	.80

a Least square means; SEM = 8.
bcd Means within a row with different superscripts differ (P<.05).
L,Q,C Linear, Quadratic or Cubic effects (P<.05)
l,q Linear or quadratic effects (P<.10)

concentration of any slaughter group. This was similar to the increase (L; P<.01) in the cholesterol concentration (mg/100 g wet tissue) within the LM. Steers being fed for 119 or less had lower (P<.05) amounts of cholesterol in the LM than steers fed for 133 d or more. Total lipid present within the LM also increased (L; P<.01) across slaughter groups, with steers being fed for 105 d having less (P<.05) LM lipid than any other slaughter group. Hoelscher et al. (1988) reported that approximately 90% of the total cholesterol found in adipose tissue was present in the storage fraction, leaving approximately 10% of the total cholesterol in the membrane fraction. Thus, increasing the amount of lipid found in the storage form, as would be the case with increased amounts of marbling, should increase the amounts of cholesterol present within the LM. When quality grade was regressed against cholesterol content of the LM, no significant quality grade by slaughter date interaction was detected. Thus, neither slaughter date or age was a factor in cholesterol deposition of the LM; instead increases in cholesterol content within the LM appear to be caused by a increase in fat content.

With time on feed, LM moisture content decreased linearly (P<.01) while moisture and protein responded quadratically (Q;P<.02). If fat replaced the moisture and protein within the LM as slaughter date increased, the amount of cholesterol within the LM would increase. When protein content of the LM was adjusted to a mean s.c. fat thickness, the Q effect of slaughter date disappeared. Hence, for our steers, feeding high concentrate diets for more than 119 d may be detrimental due to increased concentrations of cholesterol.

Although LM area was not altered by slaughter group, raw weight and cooked weight of LM steaks increased (L; P<.01) with slaughter group (Table 2). Without precise control over thickness when cutting steaks, changes in raw and cooked weight of LM steaks may indicate merely that the thickness of steaks varied. However, cooking shrink, a better indicator of relative changes, decreased (L; P<.02) at a decreasing rate (Q; P<.04) across slaughter date. The cooking time (minutes/100 g raw tissue) required to cook LM steaks to a medium degree of doneness also decreased (L; P<.01) with slaughter group. As time on feed increases, tenderness increases (Dolezal et al., 1982; Miller et al., 1987); however, this increase may be limited with a maximuim at 139 d (Epley et al., 1968) or between 150 and 180 d (Zinn et al., 1970b); after this time, the effect of animal age may decrease tendernass. May et al. (1992) fed steers between 0 and 196 d and reported that the lowest shear force value was at 112 d; with shear force values at 28 and 196 d both were greater. Tenderness of the LM in this study, measured by Warner-Bratzler shear force, tended to increase (L; P<.07; Table 2) continuously with increasing days on feed. The percentage of steaks being considered very tender (< 3.86 kg) and tender (3.86 < tender <4.54 kg) where unaffected by time on feed. However, the percentage of steaks being considered tough (> 4.54 kg) decreased (L; P<.03) with increased time on feed; steers fed for 105 d had a higher (P<.05) percentage of tough steaks than steers fed for 147 d. Even though tenderness tended to increase with time on

Table 2. Effects of slaughter group on cooking properties and shear force.[a]

	Days on Feed				
	105	119	133	147	SEM
No. Pens	8	8	8	8	
No. Steers	61	63	64	64	
Raw weight, g[LQC]	293.78[e]	294.96[e]	331.10[f]	300.83[e]	2.46
Cooked weight, g[LQC]	206.16[e]	211.27[ef]	238.19[g]	215.45[f]	1.87
Cooking Shrink, %[LQ]	29.86[e]	28.39[f]	28.05[f]	28.38[f]	.37
Cooking time, min.[L]	7.63[e]	6.91[f]	6.54[f]	6.64[f]	.23
Shear Force, kg.[l]	4.45	4.42	4.11	4.16	.13
Very Tender, %[b]	29.51	26.98	43.75	39.06	6.15
Tender, %[c]	24.59	38.10	26.56	32.81	5.18
Tough, %[dL]	45.90[e]	33.33[ef]	29.69[ef]	28.13[f]	5.17

a Least square means; SEM n = 8.
b Very Tender < 3.86 kg.
c Tender = 3.86 < Tender < 4.54 kg.
d Tough > 4.54 kg.
efg Means within a row with different superscripts differ (P<.05).
L,Q,C Linear, Quadratic or Cubic effects (P<.05)
l,q Linear or quadratic effects (P<.10)

feed, no differences were detected between 119 and 147 days on feed for shear force, or the percentage of steaks being considered tough. Thus, steers fed 119 d should have been fed long enough to be considered satisfactory in tenderness and palatability as was reported previously by Dolezal et al. (1982).

Literature Cited

AMSA. 1978. Guidelines for cookery and sensory evaluation of meat. Am. Meat Sci. Assoc. and National Live Stock and Meat Board, Chicago, IL.

AOAC. 1984. Official methods of analysis (14th Ed.) Association of Official Analytical Chemists, Washington, DC.

Dolezal, H. G. et al. 1982. Effect of time-on-feed on palatability of rib steaks from steers and heifers. J. Food Sci. 47:368.

Epley, R. J. et al.. 1968. Influence of sire and length of feeding on palatability of beef steaks. J. Anim. Sci. 27:1227.

Hicks, R. B. et al. 1987. The effect of slaughter date on carcass gain and carcass characteristics of feedlot steers. Okla. Agr. Exp. Sta. Res. Rep. MP-119:351.

Hoelscher, L. M. et al. 1988. Subcellular distribution of cholesterol within muscle and adipose tissue of beef steaks. J. Food Sci. 53:718.

Lepage, G. and C. C. Roy. 1986. Direct transestrification of all classes of lipids in a one-step reaction. J. Lipid Res. 27:114.

May, S. G. et al. 1992. Effects of days fed, carcass grade traits, and subcutaneous fat removal on postmortem muscle characteristics on beef palatability. J. Anim. Sci. 70:444.

Miller, R. K. et al. 1987. The influence of diet and time on feed on carcass traits and quality. Meat Sci. 19:303.

Zinn, D. W. et al. 1970a. Feedlot and carcass grade characteristics of steers and heifers as influenced by days on feed. J. Anim. Sci. 31:302.

Zinn, D. W. et al. 1970b. Beef muscle tenderness as influenced by days on feed, sex, maturity and anatomical location. J. Anim. Sci. 31:307.