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The effects of dietary management on beef composition and quality

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Introduction

The production of beef carcasses that maximize live animal production efficiencies and carcass characteristics is important; but nonetheless important to industry success, is the assurance of marketing a palatable product. Early research (Armsby, 1917; Bull, 1916; Henry and Morrison, 1916) established the precedent that animals fed high-energy diets produce meat cuts with superior palatability characteristics. Tatum et al., (1980) found that 90% of the cattle fed 100 to 160 d produced steaks with at least desirable palatability ratings. Many studies have confounded length of time fed with age of the animal. Consequently, it is difficult to draw well-defined conclusions about the effects of animal age and length of time an animal is fed a high concentrate diet.

Therefore, the influence of preslaughter nutrition and age on cooked beef palatability has not been adequately addressed. The objective of this study is to define: 1) the effects of prefinishing nutrition, and 2) the effects of length of time fed to a constant age at slaughter on subsequent cooked beef palatability.

Materials and Methods

Experimental Design. One hundred and sixty-two steers were randomly selected from approximately 8 mo old calves. Randomization of steers to treatments, a full description of the type of animals selected, information on the composition of diets fed, and a description on how steers were fed was presented (Miller et al., 1983a). Steers were randomly allotted to prefinishing nutrition (low=.41 kg of gain per head per day (L); high=.68 kg of gain per head per day (H) at 8 mo of age. In addition, steers (n=18) were assigned to nine length of time on feed by slaughter age treatments (no concentrate feeding (0), slaughter age = 16, 18 or 20 mo; concentrate feeding for 56 d (56), slaughter age = 16, 18 or 20 mo; concentrate feeding for 112 d (112), slaughter age = 18 or 20 mo; concentrate feeding for 168 d (168), slaughter age = 20 mo.). Only 20 mo age data will be presented here.

Data Collection. The longissimus (LM) from the loin section, was removed from the left side of each carcass 48 h postmortem. Two steaks (2.54 cm width) were removed from each muscle for sensory and shear force analysis. The 9-1-11 rib section was removed from the left side of each carcass (Hankins and Howe, 1946) approximately 24 h postmortem. Each rib section was physically dissected into separable subcutaneous fat, separable seam fat, separable lean and separable bone. Separable subcutaneous fat and separable seam fat were combined, ground and mixed as previously described. Similarly, two 100 gm samples were removed for chemical analysis. Separable lean and separable fat subsamples were each analyzed for percentage moisture and percentage ether extract (AOAC, 1970).

An 8 member descriptive attribute panel was trained and tested according to methods described by Cross et al., (1978) and AMSA (1978). Panelists evaluated each sample according to differences in juiciness (1=extremely dry, 8=extremely juicy), ease of fragmentation (1=extremely difficult, 8=extremely easy), amount of connective tissue (1=abundant, 8=none), overall tenderness (1=extremely tough, 8=extremely tender) and flavor intensity (1=extremely bland, 8=extremely intense). Steaks were broiled on a Farberware "open hearth" broiler for sensory evaluation. Internal temperature was monitored with a Honeywell 1112 multipoint recorder. Steaks were turned at 40 C internal temperature and removed from the broiler at 70 C.

Results and Discussion

This experiment was designed to examine the effects of two prefinishing nutritional regimens and the effects of subsequently feeding a high-energy density diet for 0, 56, 112 or 168 d over a constant age interval.

Prefinishing nutrition x length of time fed. Most carcass quality traits were not affected (table 1) by nutritional management. A significant interaction between prefinishing diet and time on feed was observed for quality grade, adjusted fat thickness (cm) and hot carcass weight (kg). Differences in carcass weight between L and H prefinished cattle decreased with increased length of time fed. Steers fed L, 0 d possessed the lowest (P<.05) quality grade. However, a significant increase in quality grade was not observed until L steers had been a finishing diet for 112 days. Steers from the H finishing diet did not differ (P>.05) in quality grade with increased length of time on the finishing diet. The interaction between prefinishing diet and time on feed for adjusted fat thickness paralleled quality grade (table 1).

LM steaks from L steers had (P<.05) less desirable ease of fragmentation, connective tissue amount and overall tenderness than LM steaks from H steers (table 2). Increased length of time steers were fed a high-energy diet increased sensory panel scores for connective tissue amount and decreased LM peak force (kg). However, the greatest decrease in peak force was reported after 56 d on feed and subsequent 56 d of feeding produced no significant decrease in peak force. Overall tenderness was not significantly affected by length of time fed, although tenderness ratings tended to increase slightly with each 56 d increment for length of time fed.

The interaction between prefinishing diet and time on feed was significant for separable lean (kg) (P<.05), rib weight (kg), separable fat (kg,%), moisture (%) and lipid (%) (P<.01) (table 3). At 0 d, ribs from L carcasses had the lowest separable fat and lipid, but with concomitant days on the finishing diet subsequent increases in fat were reported up to 112 d, where increased fat deposition proceeded at a lower rate. Ribs from H steers (fed 56 d) had similar separable fat and lipid to L ribs. However, after the first 56 d on the finishing diet, ribs from H steers attained reduced rates of fat deposition similar to the state attained at 112 d for the L carcasses. Moisture (%) exemplified an inverse relationship to fat deposition. Ribs from L steers that had been fed 168 d reached similar rib weight (kg) and separable lean (kg) to H ribs from steers fed 56, 112 or 168 d.

Separable bone (kg) was significantly affected by time on feed (table 3). Increased length of time on feed from 0 to 112 d on a high-energy diet resulted in increased bone deposition at a constant age; however, no significant increase in separable bone was reported after 112 d on feed. Muscle to bone ratio (table 3) increased significantly from 0 to 56 d on the high-energy diet, and with increased length of time fed, no subsequent increase in muscle to bone ratio was seen.

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TABLE 2. MEANS FOR LONGISSIMUS SENSORY PANEL AND INSTRON VALUES AT 20 MO OF AGE

Treatment	Left longissimus muscle					
	Juiciness[a]	Ease of fragmentation[b]	Connective tissue amount[c]	Overall tenderness[d]	Flavor intensity[e]	Peak force, kg
Prefinishing nutrition (P)		*	*	*		
Low	5.44	5.34	5.22	5.32	5.75	4.62
High	5.58	5.62	5.51	5.60	5.79	4.08
Length of time fed (T)[f]				*		**
0 days	5.51	5.38	5.19	5.29	5.81	5.30
56 days	5.39	5.34	5.22	5.39	5.63	4.13
112 days	5.53	5.53	5.41	5.50	5.79	4.00
168 days	5.60	5.66	5.63	5.66	5.84	3.94
Tukey	—	—	.31	—	—	.77
Residual SD	.46	.47	.47	.47	.30	1.15

[a]Scored: 1 = extremely dry; 8 = extremely juicy.
[b]Scored: 1 = extremely difficult; 8 = extremely easy.
[c]Scored: 1 = abundant; 8 = none.
[d]Scored: 1 = extremely tough; 8 = extremely tender.
[e]Scored: 1 = extremely bland; 8 = extremely intense.
[f]Number of days fed on the high-energy density diet.
*Means within a main effect or interaction within a column differ (P<.05).
**Means within a main effect or interaction within a column differ (P<.01).

TABLE 1. MEANS FOR CARCASS QUALITY GRADE CHARACTERISTICS AT 20 MO OF AGE

Treatment	Lean color[a]	Overall maturity[b]	Marbling score[c]	USDA Quality grade[d]	Hot Carcass weight kg	Adj. fat thick-ness, cm	Longi-ssimus muscle area, cm	USDA Yield Grade
Prefinishing nutrition (P)			**	**	**	**	**	**
Low	5.03	67.90	4.17	9.04	291.1	.70	73.97	2.41
High	5.11	64.16	4.84	10.53	325.0	.96	79.30	2.74
Length of time fed (T)			*	**	**	**	**	**
0 days	4.89	72.48	4.09	8.76	260.6	.50	69.52	2.10
56 days	4.87	65.03	4.40	9.55	303.9	.78	74.88	2.56
112 days	5.48	64.68	4.78	10.57	319.8	.92	79.29	2.70
168 days	5.05	61.79	4.79	10.29	348.2	1.13	82.90	2.95
Tukey	---	----	.52	---	---	----	4.67	.32
PxT					**	*		
Low, 0 days	---	----	---	7.38	225.6	.24	----	----
Low, 56 days	---	----	---	8.24	292.3	.65	----	----
Low, 112 days	---	----	---	10.59	306.5	.97	----	----
Low, 168 days	---	----	---	10.13	341.5	.97	----	----
High, 0 days	---	----	---	10.14	295.6	.75	----	----
High, 56 days	---	----	---	11.03	317.0	.91	----	----
High, 112 days	---	----	---	10.55	331.6	.89	----	----
High, 168 days	---	----	---	10.45	355.0	1.30	----	----
Tukey	---	----	---	2.66	24.4	.39	----	----
Residual SD	.85	16.94	.78	1.80	165.0	.26	6.99	.48

[a]1=black; 7=very light cherry red.
[b]99 to 0 = A; 199 to 100 = B.
[c]5=small; 4=slight; 3=traces.
[d]12=low Choice; 11=high Good; 10=average Good; 9=low Good; 8=high Standard; 7=average Standard.
[e]Number of days fed on the high-energy density diet.
*Means within a main effect of interaction within a column differ (P<.05).
**Means within a main effect of interaction within a column differ (P<.01).

TABLE 3. MEANS FOR RIB COMPOSITION AT 20 MO OF AGE

Treatment	Rib weight, kg	Separable fat, kg	Separable lean, kg	Separable bone, kg	Separable fat, %	Moisture, %	Lipid, %
Prefinishing nutrition (P)	**	**	**		**	**	**
Low	5.228	1.446	2.865	.916	26.49	54.23	29.58
High	6.098	1.864	3.290	.944	30.30	50.47	34.28
Length of time fed (T)	**	**	**	**	**	**	**
0 days	4.527	1.052	2.608	.867	22.41	57.58	25.42
56 days	5.594	1.559	3.129	.906	27.56	53.22	30.65
112 days	6.147	1.897	3.264	.986	30.71	50.05	34.74
168 days	6.407	2.121	3.324	.962	32.99	48.47	36.99
Tukey	--	--	--	.058	--	--	--
PxT	**	**	**		**	**	**
Low, 0 days	3.739	.655	2.245	--	17.52	62.17	19.65
Low, 56 days	5.205	1.277	3.028	--	24.71	55.88	27.37
Low, 112 days	5.836	1.877	2.989	--	31.88	49.19	35.94
Low, 168 days	6.200	2.025	3.213	--	32.46	49.14	36.05
High, 0 days	5.315	1.449	2.971	--	27.29	52.99	31.19
High, 56 days	6.031	1.877	3.242	--	30.77	50.23	34.33
High, 112 days	6.424	1.915	3.507	--	29.67	50.81	33.68
High, 168 days	6.615	2.218	3.434	--	33.52	47.81	37.94
Tukey	.710	.473	4.37	--	6.18	4.56	5.91
Residual SD	.480	.319	.295	.084	4.17	3.08	3.99

*Means within a main effect or interaction within a column differ (P<.05).
**Means within a main effect or interaction within a column differ (P<.01).