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Short-fed, Grass-fed, and Long-fed Beef Compared

D. H. Kropf, D. M. Allen, and G. J. Thouvenelle

Summary

Thirty carcasses, ten each from three groups - short-fed concentrate rations for about 70 days, grass-fed on Flint Hill pasture without supplemental feeding until slaughter in mid-to-late October, and long-fed concentrate rations at least 150 days - were used for taste-panel and display-color comparisons.

Carcasses from long-fed cattle were heavier, fatter, had more marbling, graded higher on quality, and had a higher yield grade (fatter). Carcasses from grass-fed beef graded lowest (five Standards and five Goods). Carcasses from short-fed beef were intermediate between long-fed and grass-fed in all measurements recorded. Carcasses of grass-fed beef had less finish than other carcasses but did not differ in yield grade from short-fed cattle carcasses.

Steaks from long-fed beef had the most desirable color after cutting and also after three days of retail display. Those from short-fed cattle were intermediate, and those from grass-fed beef were darkest, unacceptably so after three days of display. Fat on T-bone steaks from grass-fed beef was yellowest.

Cooking losses were highest from steaks from grass-fed beef. Taste panelists scored flavor, tenderness, and over-all acceptability highest for long-fed, intermediate for short-fed, and lowest for grass-fed beef steaks. Shear force supported taste panel evaluations for tenderness. Tenderness was unacceptably low for steaks from one long-fed, four short-fed, and seven grass-fed carcasses. Long-fed beef steaks were juicier but taste-panel juiciness score did not differ between short-fed and grass-fed beef steaks.

Introduction

Current high prices of feed grains suggest production of beef with less concentrate feed and more roughage, including grass pasture. However, in addition to economical beef production, we must be concerned with such product display characteristics as shelf life and color and also with consumer acceptance. Those three factors greatly influence both initial and repeat sales. This study compared short-fed, grass-fed and long-fed beef by carcass quality and yield grade, fresh display-case appearance, cooking losses, cooked product flavor, juiciness, tenderness, and acceptance.

Experimental Procedure

Short-fed cattle of known background that had been fed largely concentrate rations for about 70 days were obtained from a commercial beef slaughter plant. Grass-fed cattle that had been kept on Flint Hill pasture without supplemental concentrate feeding were obtained near the end of the 1974 grass season (mid-to-late October). Long-fed cattle were obtained from a feeding trial at the KSU Beef Research Center. They had been on feed at least 150 days. Ten cattle were used from each group.

Cattle were slaughtered after fasting overnight (16 to 18 hours). After a 24- to 48-hour chill, carcasses were ribbed and grade information was obtained (table 22.1).

A wholesale loin was cut from each carcass and shipped to the KSU Meat Laboratory. Loins were cut with a power meat saw into one-inch thick steaks at about four days post slaughter.

Steaks that were tested in display cases were removed from each loin over the fourth lumbar vertebra; bone dust was removed, the steaks were placed in styrofoam meat trays and overwrapped with polyvinyl chloride film. It is the film used by most fresh meat, self-service retailers.

One steak (boneless loin strip) was displayed three days; another five days before they were cooked and evaluated by a taste panel.

Two similar freshly cut muscles from the third lumbar vertebra from each loin were cooked without being displayed (Day 0). One was used for taste-panel evaluation and another for shear-force evaluation.

All steaks were modified broiled in a 350°F rotary oven to an internal temperature of 151°F. Weights to the nearest 0.01 gram were taken before and after cooking, to calculate cooking losses.

For taste panel evaluation, 0.5 inch cores of cooked longissimus muscle were obtained after cooling at least ten minutes. Samples contained no subcutaneous fat, heavy seams of marbling, or connective tissue. Panelists received samples from 6 different loins in random order and scored each for desirability of flavor, juiciness, tenderness and over-all acceptability. Each sample was scored by six experienced panelists.

Six ½-inch cores were removed from one steak from each carcass that was cooked the same day the loins were cut. After cooking and cooling they were subjected to Warner-Bratzler shear-force tests. Shear-force was determined to the nearest 0.1 pound.

Visual color was evaluated on three muscles as steaks went on display test and after three days of display at about 32°F under 100-foot candles of Delux Warm White lighting. Display was continuous, i.e., 24 hours a day. Color was evaluated on longissimus (loin or rib eye) muscle and psoas major (tenderloin) muscle of the T-bone from which the longissimus would be removed for taste panel evaluation after 5 days of display. In addition, color was evaluated on gluteus medius, a muscle from the top sirloin steak.

Visual color was scored independently by four persons using the KSU Beef Color Standards to the nearest 0.5 point.

Analysis of variance was used with least significant difference to determine significance of differences between means.

Results and Discussion

Carcass Weights and Grades

Carcasses averaged 501, 532, and 615 pounds, respectively, for grass-fed, short-fed, and long-fed cattle (table 22.1).

Distribution of carcass quality grades for carcasses is given in table 22.1. Only one of ten short-fed beef carcasses graded Choice, but three more graded Good+ and all were Good or better. Carcasses from grass-fed cattle were equally divided between the Standard and Good grades and carcasses from long-fed beef were equally divided between Choice and Good, a lower than expected proportion of Choice.

Conformation score was highest for carcasses from the long-fed group (Choice+), lowest for those from grass-fed cattle (Good-) and intermediate for short-fed (Good+). This is partly due to influence of finish on conformation score.

Carcass maturity score for long-fed cattle suggested that they were younger than the other animals, possibly because their muscle color was brighter.

Marbling scores were highest for carcasses from long-fed cattle with an average of typical Small; scores from grass-fed beef averaged Traces-, which is customary for the top end of the Standard grade; marbling from the short-fed group averaged Slight+, typical of Average Good.

Fat averaged thickest for carcasses from long-fed cattle and thinnest from the grass-fed group, as expected. Rib-eye area was least for grass-fed cattle, a reflection of their lighter carcasses.

Kidney, pelvic, and heart fat percentages averaged 2.6 for short-fed, 2.3 for grass-fed, and 3.4 for long-fed groups.

Yield grades did not differ between short-fed and grass-fed groups, but for the fatter long-fed group yield grade was higher.

Fat Color

Fat on T-bone steaks from the grass-fat group was yellowest as expected (table 22.2). That degree of yellow color is not a marketing problem in all areas of the U.S., except where consumers are sensitive to differences in fat color.

Muscle Color

Freshly packaged (Day 0) beef steak muscles from long-fed beef have the most desirable color; those from grass-fed beef, least desirable (table 22.2). The longissimus (loin eye or rib eye) from grass-fed beef was especially

darker than those from the other groups. Some steaks from grass-fed beef tended toward "dark cutters."

As all animals were fasted 18 to 24 hours before being slaughtered, it appears that grass-fed beef cattle are more sensitive to pre-slaughter feed withdrawal so shorter fasting periods may be appropriate for them.

A color score of 3.5 is considered marginally unacceptable. Higher scores indicate likely rejection by meat purchasers. All muscles were "saleable" after cutting and packaging, but those from long-fed beef were most attractive.

After three days of display, muscles from long-fed beef were still most desirable in color. Color score differed little between short-fed and grass-fed beef, *psaos major* (tenderloins), and *gluteus medius* (sirloin muscles), although *longissimus* (loin or rib eye) from grass-fed beef was noticeably darker than from short-fed beef. After three days' display, all three muscles from grass-fed beef approached undesirable color, while those from long-fed beef were still acceptable.

Therefore, cuts from grass-fed beef would present marketing problems if merchandized in unfrozen state.

Cooking Loss, Shear Force and Taste Panel Results

Cooking-loss percentages from boneless top loin steaks (loin strip steaks) prepared by modified broiling to an internal temperature of 151°F did not differ between short-fed and long-fed cattle, but about 1% more was lost by steaks from grass-fed cattle (table 22.3).

Feeding treatment affected taste panel evaluations of steaks taken shortly after cutting (Day 0) and after three or five days of refrigerated display that simulated retail display for cuts packaged in polyvinyl chloride film.

Steaks from long-fed cattle displayed 0, three, or five days were most desirable; those from short-fed cattle, intermediate; and those from grass-fed cattle, least desirable in flavor score. Panelists noted sweet, metallic, or grassy flavor in some steaks from grass-fed cattle.

Table 22.4 shows mean flavor scores for steaks from each carcass in each group ranked from least to most desirable. When flavor scores are arbitrarily divided into acceptable and unacceptable halfway between six (slightly desirable) and seven (moderately desirable), four short-fed carcasses and five grass-fed carcasses average unacceptable, while steaks from all long-fed carcasses were acceptable.

Juiciness scores did not differ between short-fed and long-fed groups but were lower for steaks from grass-fed cattle. All groups had acceptable mean juiciness scores.

Tenderness scores were lowest for steaks from grass-fed beef and highest for those from long-fed beef after 0, three, and five days' display. Although tenderness scores of steaks from long-fed beef carcasses exceeded those from short-fed carcasses, both averaged near seven (moderately tender), but steaks from grass-fed cattle lacked tenderness.

Mean tenderness scores of each carcass (table 22.5), showed seven of ten from the grass-fed group, four of ten from the short-fed group, and one of ten from the long-fed group to be unacceptable.

Shear-force values (table 22.4) also show low tenderness for steaks from grass-fed cattle.

All of the taste-panel, shear-force, and cooking data were from steaks cooked by modified broiling, a dry heat procedure, so the results would not apply to other cuts or other methods of cookery. Perhaps other cooking methods should be recommended for steaks from grass-fed cattle. Further comparisons of short-fed, grass-fed, and long-fed beef should include roast cuts and cuts cooked by moist heat.

Table 22.1. Comparative Data From Carcasses of Short-fed, Grass-fed, and Long-fed Beef.

	Short fed	Grass fed	Long fed	Variance ratio	Least sig. diff.
Carcass wt., lbs. average range	532.5 437-664	501.0 396-554	614.9 551-844		
Conformation score ^d	9.3 ^b	7.3 ^c	11.8 ^a	22.95 ^{**}	0.96
Maturity ^e	1.9	2.1	1.5		
Marbling ^f	11.8 ^b	7.3 ^c	13.6 ^a	12.14 ^{**}	1.91
Carcass quality grade					
Av. Choice	1		2		
Choice-			3		
Good+	3		4		
Av. Good	4	1	1		
Good-	2	4			
Standard+		2			
Av. Standard		3			
Fat thickness, in.	0.36 ^b	0.19 ^a	0.53 ^c	20.39 ^{**}	0.08
Rib eye area	10.9 ^a	9.5 ^b	11.6 ^a	5.60 ^{**}	0.89
Rib eye/cwt.	2.05	1.90	1.89		
Yield grade	2.4 ^a	2.2 ^a	3.1 ^b	9.75 ^{**}	0.31

^{**}P<1%.

^{a,b,c}Means in same row with same superscript letters do not differ (P<5%).

^dConformation score: Avg. Standard = 5, Avg. Good = 8, Avg. Choice = 11, Avg. Prime = 14.

^eMaturity: A- = 1, A = 2, A+ = 3.

^fMarbling: Prac. devoid = 5, traces = 8, slight = 11, small = 14.

Table 22.2. Fat and Muscle Colors From Short-fed, Grass-fed, and Long-fed

	<u>Fat and muscle color</u>				Least sig. diff.
	Short fed	Grass fed	Long fed	Variance ratio	
Fat color ^d	1.35 ^a	2.20 ^b	1.20 ^a	18.58 ^{**}	0.256
Muscle color ^e					
Longissimus					
Day 0	2.19 ^b	3.00 ^c	1.94 ^a	88.61 ^{**}	0.117
Day 3	2.96 ^b	3.81 ^c	2.46 ^a	171.74 ^{**}	0.104
Psoas major					
Day 0	2.44 ^b	2.74 ^c	2.26 ^a	19.48 ^{**}	0.108
Day 3	3.55 ^b	3.58 ^b	3.29 ^a	6.12 ^{**}	0.128
Gluteus medius					
Day 0	2.34 ^b	2.72 ^c	1.99 ^a	84.01 ^{**}	0.080
Day 3	3.45 ^b	3.49 ^b	2.91 ^a	26.86 ^{**}	0.123

^{**} $P < .01$.

^{a,b,c} Means in same row with same superscript letter do not differ ($P < .05$).

^d Fat color: 1 = white, 2 = slightly yellow, 3 = moderately yellow.

^e Muscle color: 1 = very bright red, 2 = bright red, 3 = slightly dark red or brown, 4 = dark red or brown, 5 = extremely dark red or brown.

Table 22.3. Indicated Characteristics of Longissimus Steaks from Short-fed, Grass-fed, and Long-fed Beef Carcasses Compared.

	Short fed	Grass fed	Long fed	Variance ratio	Least sig. diff.
Day 0					
Flavor ^d	6.82 ^b	6.45 ^c	7.28 ^a	7.62**	0.295
Juiciness ^d	7.18 ^a	6.68 ^b	7.44 ^a	5.35**	0.329
Tenderness ^d	6.88 ^b	5.22 ^c	7.41 ^a	90.44**	0.238
Acceptability ^d	6.80 ^b	5.88 ^c	7.36 ^a	46.20**	0.217
Shear force, lbs.	7.54 ^b	10.70 ^c	7.01 ^a	1194.52**	0.114
Day 3					
Flavor	7.00 ^b	5.94 ^c	7.26 ^a	28.51**	0.273
Juiciness	7.06 ^a	6.32 ^b	7.12 ^a	12.46**	0.249
Tenderness	6.92 ^b	5.40 ^c	7.66 ^a	81.89**	0.252
Acceptability	6.85 ^b	5.65 ^c	7.33 ^a	52.80**	0.237
Day 5					
Flavor	6.88 ^b	5.94 ^c	7.53 ^a	29.92**	0.290
Juiciness	7.22 ^a	6.57 ^b	7.46 ^a	7.97**	0.325
Tenderness	6.96 ^b	5.49 ^c	7.78 ^a	233.12**	0.151
Acceptability	6.98 ^b	5.71 ^c	7.59 ^a	88.41**	0.202
Cooking loss ^e	12.61 ^a	13.74 ^b	12.75 ^a	2.72*	0.748

**P<.01, *P<.05.

a,b,c Means within row with same letter superscript not different (P<.05).

^d Flavor, juiciness, tenderness and over-all acceptability evaluated using 9 point scale (9 = most desirable, 6 = slightly desirable, juicy or tender). Modified broiling at 350°F to 151°F for one-inch steaks.

^e Cooking losses percentage (by weight) of steaks.

Table 22.4. Flavor of Steaks From Carcasses of Short-fed, Grass-fed, and Long-fed Beef^a.

Ranked individual carcass flavor scores ^b		
Short-fed	Grass-fed	Long-fed
5.7 ^c	5.2	6.8
6.2	5.3	6.9
6.3	5.8	7.0
6.5	6.3	7.1
6.7	6.5	7.1
6.9	6.7	7.4
7.2	6.7	7.6
7.4	7.2	7.6
7.7	7.3	7.6
7.9	7.7	7.7

^aLongissimus (loin eye) steaks, 1 inch thick, modified broiled at 350°F to 151°F. No display.

^bFlavor scores: 8 = Desirable, 7 = Moderately desirable, 6 = Slightly desirable, 5 = acceptable.

^cMean for 6 taste panelists. Line in column represents an arbitrary distinction between less desirable and desirable steaks.

Table 22.5. Tenderness of steaks From Carcasses of Short-fed, Grass-fed, and Long-fed Beef^a.

Ranked individual carcass tenderness scores ^b		
Short-fed	Grass-fed	Long-fed
4.9 ^c	3.7	5.8
5.9	3.8	6.9
6.0	3.8	7.0
6.3	4.3	7.2
6.8	4.5	7.2
7.0	4.9	7.7
7.3	5.7	7.9
8.2	6.8	8.0
8.2	7.7	8.0
8.3	7.7	8.5

^aLongissimus (loin eye) steaks, 1 inch thick, modified broiled at 350°F to 151°F. No display.

^bTenderness score: 9 = Extremely tender, 7 = Moderately tender, 6 = Slightly tender, 5 = Acceptable, 4 = Slightly tough, 3 = Moderately tough.

^cMean for 6 taste panelists. Line in column represents an arbitrary distinction between less desirable and desirable steaks.