

CONSUMER ACCEPTANCE OF BEEF PRODUCED UNDER ALTERNATIVE FEEDING SYSTEMS

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Much of the beef produced and sold in the United States before World War II was from grass- or limited grain-fed cattle. However, development of the modern large-scale cattle feeding industry in the 1950s and 1960s greatly increased supplies of grain-fed beef and, by the early 1970s, many American consumers found only USDA Choice beef from heavy, grain-fed cattle in supermarkets. Consumers soon became conditioned to the flavor, juiciness, and tenderness of high quality, well-marbled beef. Proponents of forage or limited grain finishing systems found little support at any marketing level.

However, during the 1970s, beef from heavy, grain-fed cattle became the subject of health controversies. Research results linked the consumption of animal fats with several serious human health problems other than obesity (Thomas). By the late 1970s, the federal government was attempting to convince Americans to use vegetable fats rather than animal fats, in line with the "dietary goals" philosophy (Senate Select Committee on Nutrition and Human Needs). Marketers of beef from heavy, grain-fed cattle found themselves in an uncomfortable, defensive position.

The cattle cycle greatly influenced supplies of heavy, grain-fed animals in the 1970s. From 1973 through 1975, grain-fed beef supplies were reduced because rising feed grain prices caused many feedlots to operate at greatly reduced volumes and at heavy economic losses. Forage-fed cattle gained a larger share of total beef cattle slaughter beginning in 1975 when depressed live cattle prices forced producers to begin liquidation of overbuilt beef breeding herds. Much forage-fed beef was converted into ground beef, and the fast food industry prospered. However, feedlot finished animals started to regain their share of total beef cattle slaughter in 1976 and by mid-1979 had nearly regained the position held in the early 1970s. Forage-fed beef cattle slaughter and total beef cattle slaughter dropped as the liquidation phase of the cattle cycle neared the end.

Demand theory suggests that factors related to human health and the availability of beef supplies should influence consumer beef preferences. Consumer preference for beef from heavy, grain-fed cattle may have changed to an acceptance of beef from leaner, lighter cattle finished with greater use of forages. Therefore, in 1974, Louisiana State University researchers initiated a multiphase research project to determine the consumer acceptability of beef produced on high quality forage or limited grain diets.

Objectives of the research project were to determine (1) the consumer acceptability of beef from steers differing in genetic composition finished on alternative feeding programs and (2) the extent of grain feeding needed for consistent production of consumer-acceptable beef, and (3) to compare consumer panel "suggested prices" for steaks from steers differing in breeding and feeding treatment with regular supermarket prices for USDA Choice beef. It was hypothesized that consumer panel members would not discriminate among feeding treatments or breeds in evaluating selected palatability characteristics of steaks or in expressing the value of these steaks in terms of prices.

The overall project was divided into two parts. Part A was a three-phase study of the consumer acceptability of beef from Angus or Hereford \times Angus steers finished on forages alone or with limited amounts of grain. Part B, a two-phase study, evaluated Brahman cross and British cross steers finished on forages alone or with limited amounts of grain. The breeding of each of the Brahman cross steers was about a fourth Brahman and about three-fourths British.

TREATMENTS AND PROCEDURES

All test steers were selected and finished from herds maintained on branch stations of the Louisiana Agricultural Experiment Station. The steers were on comparable pre- and

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postweaning forage grazing programs prior to assignment to finishing treatments, which was accomplished in an unbiased manner although approximate uniformity in animal weight among treatments within phases was obtained by arbitrary selection.

Part A consisted of five, four, and four feeding treatments in Phases I, II, and III, respectively, and Part B consisted of two phases (Phases IV and V), each including four feeding treatments (Table 1). Feeding treatments in Part A ranged from pasture grazing to 140 days grain in feedlot. Part B feeding treatments ranged from pasture grazing to 70 days grain in feedlot.

Steers from each treatment in Phases I and II were custom slaughtered at the same time. As rates of gain differed among feeding treatments, average slaughter weights differed. Ages at slaughter were 23 and 30 months for Phases I and II, respectively. In Phase III, all steers were custom slaughtered at an average treatment weight of 1050 pounds and at ages ranging from 24 to 29 months. In Part B (Phases IV and V), steers from the two feeding treatments (forage and 70-day feedlot) were custom slaughtered at different weights and ages, 32 and 30 months for forage-fed steers and 22 and 25 months for 70-day feedlot steers,

respectively. Slaughter weights exceeded 1000 pounds except for three treatments in Phase II (pasture, grain on pasture, and 70-day feedlot) and one treatment in Phase IV (70-day feedlot).

Forage-fed steers in each phase grazed ryegrass before slaughter except in Phase II, the steers of which were slaughtered directly off bermudagrass pastures. All steers on feedlot treatments were on full concentrate rations at the time of slaughter. Steers finished with grain while on pasture consumed the equivalent of one-half of 1 percent of body weight of a grain ration per head per day in Phase I and 1 percent in Phases II and III.

Five household consumer panels, one for each phase, were randomly selected from geographic clusters within the city of Baton Rouge, Louisiana. Households in the panels numbered 150, 273, 158, 144, and 120 for Phases I, II, III, IV, and V, respectively. Each household in Phases I-III received, free, two loin, two round, and two chuck steaks, delivered frozen, over a three-week period. Rib steaks were substituted for chuck steaks in Phases IV and V. Each panel member (husband and wife) during a particular delivery received steaks from the same position on the wholesale cut although from different carcasses. Panel members were requested to not use

TABLE 1. SELECTED STEER AND CARCASS CHARACTERISTICS, PARTS A AND B

Part, Phase and Treatment	Number of Head	Age at Slaughter (Months)	Month and Year of Slaughter	Final Weight (Pounds)	Fat Thickness (in)	Quality Grade ^a
Part A (British X)						
Phase I						
Pasture	10	23	2-75	1014	.23	9.9
Grain on Pasture ^b	10	23	2-75	1040	.26	10.1
63 Day Feedlot	10	23	2-75	1047	.29	10.4
78 Day Feedlot	10	23	2-75	1099	.33	10.8
108 Day Feedlot	10	23	2-75	1085	.32	10.7
Phase II						
Pasture	16	20	10-75	837	.13	8.6
Grain on Pasture ^b	16	20	10-75	929	.29	9.5
70 Day Feedlot	16	20	10-75	962	.39	10.8
140 Day Feedlot	16	20	10-75	1049	.51	11.3
Phase III						
Pasture	14	29	4-77	1052	.33	10.6
Grain on Pasture ^b	14	24	10-76	1049	.49	11.4
70 Day Feedlot	14	25	11-76	1056	.41	12.0
60 - 70 ^c	14	24	10-76	1047	.47	12.2
Part B (British X and Brahman X)						
Phase IV						
Pasture	24	32	5-78	1060	.22	8.7
70 Day Feedlot	24	22	9-77	972	.33	8.9
Phase V						
Pasture	20	30	6-79	1091	.23	8.8
70 Day Feedlot	20	25	12-78	1130	.43	10.6

^aEach quality grade is divided into three parts (low, average, high): low Standard = 6, low Good = 9, low Choice = 12.

^bIn Phase I, one half of one percent of body weight per head per day of a grain ration was fed. In Phases II and III, the amount was increased to one percent.

^c60 days one percent grain on pasture followed by 70 days grain in feedlot.

artificial tenderizers; otherwise, steak preparation was at their discretion.

Selected socioeconomic characteristics of the combined household panels for Parts A and B of the study are given in Table 2. Nearly 50 percent of the homemakers were under 40 years old. Approximately 53 and 65 percent of the homemakers reported some education beyond high school in Parts A and B, respectively. Annual incomes greater than \$20,000 were reported by 36 and 55 percent of the households in Parts A and B, respectively. Nonwhite members comprised 20 to 25 percent of each panel.

An evaluation form was delivered with each steak. Steaks were rated for tenderness, flavor, juiciness, and overall acceptability on seven-point hedonic scales. The scales used descriptive terminology appropriate for each of the traits, ranging from the equivalent of "highly desirable" to "highly undesirable." Analysis of variance was used to test hypotheses of no differences in ratings or consumer "suggested" prices among finishing treatments or breeds within phases. Duncan's New Multiple Range Test was used to analyze differences in ratings or prices among specific treatments within phases.

EVALUATIONS OF THE BEEF

Fat thickness, an excellent indicator of overall fat content, increased as the steers consumed additional grain (Table 1). Quality grade, primarily determined by the amount of intramuscular fat, increased as grain consumption increased. Only 75 of the 258 steers graded Choice or higher, 97 graded Good, and the remaining 86 steers graded Standard. Therefore, beef from 183 carcasses (71 percent) would have been ineligible for sale in most of the nation's supermarkets.

Significance levels of treatment and breed effects by phase are given in Table 3. The consumer panels detected differences in tenderness among feeding treatments in Phase I and in tenderness, flavor, and juiciness in Phase II.¹ Differences in flavor between breeds were detected in Phase IV. Otherwise, differences in palatability scores for feeding treatments and breeds were not significant.

Household panel average ratings by feeding treatment are given in Table 4. The grain-fed beef in Phase II was rated superior to the forage-fed beef. However, the 70-day feedlot finished steers outweighed the forage-fed steers by 125 pounds at slaughter. Panel members

TABLE 2. SELECTED SOCIO-ECONOMIC CHARACTERISTICS OF THE HOUSEHOLD PANELS, PARTS A AND B

Part and Phase	Age of Homemaker		Education of Homemaker		Annual Family Income	
	Years	%	Level	%	Dollars	%
Part A						
Phases II - III ^a	< 30	24.8	Elementary	4.2	< 10,000	19.3
	30-39	24.6	High School	42.3	10,000-19,999	44.5
	40-49	20.2	College ^b	49.0	20,000-29,999	24.2
	50-59	20.2	Other ^c	4.5	30,000-50,000	10.2
	≥ 60	10.2			> 50,000	1.8
Part B						
Phases IV - V	< 30	22.8	Elementary	5.8	< 10,000	10.5
	30-39	26.8	High School	29.3	10,000-19,999	34.1
	40-49	19.2	College	58.0	20,000-29,000	35.5
	50-59	15.6	Other ^c	6.9	30,000-50,000	15.2
	≥ 60	15.6			> 50,000	4.7

^aA different set of categories was used in Phase I.

^bIncludes homemakers reporting education in Other category during Phase II.

^cIncludes business, nursing, vocational-technical school, etc.

¹Statistical differences referred to in the text are at the 5 percent level of significance.

TABLE 3. ANALYSIS OF VARIANCE OF FEEDING TREATMENT AND BREED EFFECTS ON CONSUMER PANEL RATINGS, PARTS, A AND B^a

Source	DF	Probability of "P"			Overall
		Tenderness	Flavor	Juiciness	
Feeding Treatment					
Part A					
Phase I	4	.014	.777	----	.802
Phase II	3	.002	.027	.015	.082
Phase III	3	.936	.185	.321	.392
Part B					
Phase IV	1	.217	.823	.706	.856
Phase V	1	.246	.714	.811	.713
Breed					
Part B					
Phase IV	1	.761	.001	.327	.085
Phase V	1	.984	.542	.249	.903

^aIn symbolic terms the model used is as follows:

$Y_{ij} = M_i + e_{ij}; i = 1, \dots, t; j = 1, \dots, n;$
 Where: Y_{ij} is the j^{th} response on the i^{th} treatment;
 M_i is the mean of the i^{th} treatment;
 e_{ij} is a random variable which is assumed to have a mean of zero and a variance of σ^2 ;
 t is the number of treatments; and
 n_i is the total number of observations on the i^{th} treatment.
 The test of hypothesis of interest is:
 $H_0: M_k = M_e$ for all $k, 1$
 $H_1: M_k \neq M_e$ for some k and $1, k \neq 1$.

TABLE 4. CONSUMER PANEL RATINGS BY FEEDING TREATMENT, PARTS A AND B

Parts, Phases and Treatments	Rating a			
	Tenderness	Flavor	Juiciness	Overall
Part A				
Phase I				
Pasture	3.11 ^b	2.03 ^b	----	2.45 ^b
Grain on Pasture	2.89 ^{bc}	1.94 ^b	----	2.35 ^b
63 Day Feedlot	3.11 ^b	1.89 ^b	----	2.39 ^b
78 Day Feedlot	2.67 ^{bc}	1.92 ^b	----	2.25 ^b
108 Day Feedlot	2.61 ^c	1.87 ^b	----	2.33 ^b
Phase II				
Pasture	3.27 ^b	3.10 ^{bc}	3.16 ^b	2.33 ^b
Grain on Pasture	3.13 ^{bc}	3.11 ^c	2.95 ^{bc}	2.25 ^b
70 Day Feedlot	2.67 ^d	2.91 ^b	2.78 ^c	2.01 ^b
140 Day Feedlot	2.75 ^{cd}	2.92 ^{bc}	2.80 ^c	2.15 ^b
Phase III				
Pasture	3.23 ^b	2.94 ^b	2.95 ^b	2.43 ^b
Grain on Pasture	3.17 ^b	2.88 ^b	3.13 ^b	2.34 ^b
70 Day Feedlot	3.16 ^b	2.76 ^b	2.88 ^b	2.32 ^b
60 - 70	3.24 ^b	2.98 ^b	3.05 ^b	2.53 ^b
Part B				
Phase IV				
Pasture	3.43 ^b	2.92 ^b	3.32 ^b	2.40 ^b
70 Day Feedlot	3.27 ^b	2.91 ^b	3.36 ^b	2.38 ^b
Phase V				
Pasture	3.61 ^{b/}	2.96 ^{b/}	3.44 ^b	2.44 ^b
70 Day Feedlot	3.45 ^{b/}	2.93 ^{b/}	3.47 ^b	2.48 ^b

^a1 - 7 hedonic scales, 1 = highest rating.

^{bcd}Means of treatments within phases with the same letter superscript are not statistically different at $P < .05$.

^e60 days one percent grain on pasture followed by 70 days grain in feedlot.

found no differences between the 70-day and 140-day feedlot produced beef in Phase II.

Consumer panels did not distinguish among feeding treatments for any of the four palatability characteristics when forage-fed steers weighed 1050 pounds or more at slaughter, such as those in Phases III, IV, and V. Average age of the forage-fed steers in these three phases was 29 months or greater.

Consumer panel members rated the British cross beef superior in flavor to the Brahman cross beef in Phase IV (Table 5). The Brahman

TABLE 5. AVERAGE CONSUMER PANEL RATINGS BY BREED, PART B

Phase and Breed	Ratings a			
	Tenderness	Flavor	Juiciness	Overall
Phase IV				
British X	3.34 ^b	2.78 ^b	3.29 ^b	2.30 ^b
Brahman X	3.37 ^b	3.05 ^c	3.40 ^b	2.47 ^b
Phase V				
British X	3.52 ^b	2.98 ^b	3.53 ^b	2.47 ^b
Brahman X	3.52 ^b	2.92 ^b	3.39 ^b	2.45 ^b

^a1 - 7 hedonic scale, 1 = highest rating.

^bMeans of breeds within phases with the same letter superscript are not statistically different at $P < .05$.

cross steers produced carcasses graded lower in quality with noticeably less marbling.

PRICING RESPONSES

Panel members during Phases III, IV, and V were informed of the average prevailing supermarket prices for loin and round steaks (Table 6), which increased in Baton Rouge during the period covered by the three phases. On the basis of the supermarket prices for USDA Choice beef and their evaluation of the steaks, panel members valued (priced) the steaks they consumed. Panel "suggested prices" were lower than the supermarket prices, especially in Phase IV. Lower panel prices were expected because beef prices had risen rapidly and the supermarket prices were regular and unspecialized. Consumer "suggested prices" for loin and round steaks did not differ significantly among feeding treatments or breeds (Table 6.)

IMPLICATIONS

Forage-fed steers produced carcasses with acceptable physical characteristics except in Phase II, in which case steers were slaughtered in October directly off mature, poor quality bermudagrass pastures. Phase II forage-fed steers were lighter, younger, trimmer, and of lower quality than forage-fed steers in other phases.

Tenderness, flavor, juiciness, and overall acceptability ratings by feeding treatment and

TABLE 6. CONSUMER PANEL PRICING OF LOIN AND ROUND STEAKS, BY FEEDING TREATMENT AND BREED, PARTS A AND B

Item	Type of Steak	
	Loin	Round
-----dollars / lb.-----		
Supermarket Prices ^a		
Part A		
Phase III	2.99	1.99
Part B		
Phase IV	4.06	2.86
Phase V	4.12	3.08
Panel Suggested Prices ^b		
Part A		
Phase III		
Pasture	2.37	1.58
Grain on Pasture	2.42	1.65
70 Day Feedlot	2.26	1.75
60 - 70 ^c	2.30	1.69
Part B		
Phase IV		
Pasture	2.91	2.09
70 Day Feedlot	3.00	2.13
British X	2.98	2.09
Brahman X	2.93	2.13
Phase V		
Pasture	3.12	2.40
70 Day feedlot	3.15	2.48
British X	3.19	2.48
Brahman X	3.09	2.39

^aUSDA Choice prices from a survey of Baton Rouge chain supermarkets.

^b"Prices" suggested by panel members based upon regular supermarket prices and their evaluation of the steaks.

^c60 days one percent grain on pasture followed by 70 days grain in feedlot.

breed were in the desirable half of the evaluation scales. Thus, consumer panel members considered beef from all treatments and breeds evaluated to be acceptable for these four palatability traits.

Steers with a fourth or less Brahman breeding and the rest British breeding produced beef that was acceptable, except possibly in terms of its flavor. Consumer acceptance of beef from cattle with higher percentages of Brahman breeding, produced under the finishing programs used in Phases IV and V, remains to be determined.

Feedlot periods exceeding 70 days did not improve consumer panel ratings; therefore,

British type, fleshy yearling steers fed on high quality pastures appear to require only 70 days in feedlot to produce fully acceptable beef.

Consumer acceptance was equal for beef from steers fed for 70 days in feedlot and for beef from steers fed for more than 280 days on pastures with supplemental grain, as in Phase III. Moreover, the 70-day feedlot steers consumed an average of 800 pounds less grain per head than steers fed on pastures with supplemental grain.

We do not suggest that the method used to estimate prices for loin and round steaks in Phases III, IV, and V determined how much individuals would have paid in the marketplace for the steaks consumed. However, we consider comparisons of these suggested prices among feeding treatments and breeds to be valid. Apparently, differences in steaks among feeding treatments and breeds were too small for consumers to record in terms of dollars.

Consumers have been characterized as "revolting" against rapidly rising beef prices in the 1970s. Some evidence of consumer resistance can be derived from the unusually large spread between supermarket prices and panel "suggested prices" for Phase IV, a period of rapidly rising beef prices. Some panel members may have consciously registered their objections to the sudden price increases by deliberately recording low prices. Others, however, who were accustomed to historically lower beef prices, may simply have reflected an unconscious bias toward lower beef prices.

Feeding systems used in the study produced beef on a highly seasonal basis. Research is needed to develop systems for producing beef from forage-based rations on a year-round basis. Year-round feeding systems will probably involve both spring- and fall-dropped calves, grain feeding, and silage feeding.

In conclusion, our results lead us to question the necessity of the long grain feeding periods used to produce the USDA Choice beef required by many beef retailers. Feeding treatment had no effect on beef acceptance or "value" as perceived by panel members when slaughter weights of British cross steers exceeded 1050 pounds. Any substantial reduction in grain feeding of cattle could have broad economic and social implications for the beef industry, the feed grain industry, and the beef-consuming public.

REFERENCES

- Duncan, David. "New Multiple Range and Multiple F Tests." *Biometrics*. 11 (1955):1-42.
- Senate Select Committee on Nutrition and Human Needs. "Dietary Goals for the United States." Washington, D.C.: U.S. Government Printing Office, Feb. 1977.
- Thomas, Leo H. "Mortality from Arteriosclerosis Disease and Consumption of Hydrogenated Oils and Fats." *Brit. J. Prev. and Soc. Med.* June 29, 1975, 82-9.

