GROWTH, CARCASS, CHEMICAL AND PALATABILITY TRAITS OF CROSSBRED STEERS MANAGED FOR ACCELERATED BEEF PRODUCTION

Tom Sturgeon[1], J.R. Kropp[2], D.S. Buchanan[2],
H.G. Dolezal[3] and F.K. Ray[3]

Story in Brief

Forty-one steers representing seven different breed types (purebred Angus, Brahman crossbreds, Charolais-sired crossbreds, purebred Herefords, Limousin-sired crossbreds, Simmental-sired crossbreds and Angus x Hereford) were weaned, transported to a commercial feedlot and finished under normal feedlot conditions. Steers were slaughtered when 60% of a particular breed type was estimated to grade low choice; however, the maximum feeding period was deemed to be 180 days regardless of grading potential. Carcass data were collected as well as 9-10-11th rib composition, taste panel evaluation, shear force and cholesterol content. The Charolais-sired and Simmental-sired crossbreds were frame 6 while all other breed types were frame 4 upon entrance to the feedlot. Charolais-sired, Limousin-sired and Simmental-sired calves were leaner, heavier muscled and higher cutability cattle. Angus, Angus x Hereford and Hereford steers had higher USDA quality grades, but were appreciably fatter with lower cutability. The Brahman crossbreds had low quality grades and low cutability scores as well. Rib composition was related to USDA quality and yield grade with respect to lean and fat. Taste panel evaluations indicated no practical difference among breed groups with all ratings well within the acceptable range. Shear force values did not correspond with expected tenderness projections based upon quality grades.

(Key Words: Feedlot Calves, Accelerated Production, Carcass Traits, Beef Palatability.)

Introduction

Through the years, beef production management systems have changed due to advanced technology, economics, consumer demands, as well as

---

[1]Graduate Assistant, [2]Professor, [3]Associate Professor

changes in cattle type and the influence of new breeds. Our traditional beef production system has been geared to produce choice beef from almost any size, shape and description of steer or heifer. The typical beef management system has been to wean 7- to 8-month old calves weighing 350 to 450 lb, pasture the cattle on largely a forage diet until they reach 600 to 700 lb, then finish the cattle in a feedlot on high grain rations until they reach an apparent choice quality grade, usually at approximately 1000 to 1200 lb live weight. Total production efficiency can be greatly enhanced by increasing the efficiency of the post-weaning growth phase. Placing steers directly into the feedlot after weaning, thereby eliminating the stocker phase, may increase the total production efficiency of the beef system. However, cattle in an accelerated beef production system are much younger at slaughter and consequently do not typically deposit sufficient intramuscular fat to meet the minimum specifications for the choice quality grade under current grading standards. Marbling, currently the principal criterion used in the quality grading standards among feedlot cattle, is positively related to flavor, juiciness and tenderness. However, marbling has been shown to be of less value in segmenting lean, youthful carcasses for palatability. Previous research has indicated that days on feed and/or subcutaneous fat thickness could be used as alternatives to the present quality grading system for predicting beef palatability. Feeding younger cattle in accelerated production systems may require alternative methods of marketing and subsequent value determinations to offset the pricing discounts of select (slight marbling) beef.

The objectives of this study were to compare the growth, carcass, chemical and palatability traits of differing crossbred steer groups of known history managed for accelerated beef production.

Materials and Methods

Forty-one steers representing seven different breed types were selected from the Oklahoma State University Cooperative Extension Steer Feedout Program. Breed types represented were Angus, Brahman crossbreds, Charolais-sired crossbreds, Hereford, Limousin-sired crossbreds, Simmental-sired crossbreds and Angus x Hereford. Six steers from each breed type were evaluated except for the Brahman crossbred group which contained only five steers.

At approximately three weeks post-weaning, the steers were placed in a commercial feedlot (November 12, 1986). The average age of the steers at this time was 252 days with a range of 226 to 294 days. All steers were dewormed, treated for lice and brubs, vaccinated for IBR, EVD, PI_3, 4 way Blackleg and leptocpirosis and implanted with 36 mg of zeranol. A second implant was administered at mid test (approximately 75 days).

Four rations, ranging from approximately 50% to 90% concentrate, were used during the feeding period (Table 1). The goal of the feeding strategy was to adjust the steers to the high concentrate ration as quickly as possible while minimizing digestive problems. Steers were fed ad libitum in bunk line feeders and managed under normal feedlot conditions.

All steers were individually weighed and measured for hip height at the beginning of the feeding period. A second weight was obtained at 14 days to equalize pre-delivery management effects. Check weights were obtained on all steers on day 78 of the feeding period. Final weights were obtained on Angus, Brahman crossbred, Hereford and Angus x Hereford steers on day 162 while Charolais-sired, Limousin-sired and Simmental-sired crossbred steers were weighed off test on day 176 of the feeding period. All weights reported are actual weights with no shrink.

The intent was to slaughter the steer groups when it was estimated that 60% of the cattle should grade low choice (.5 inches fat at the 12th rib); however, the maximum feeding period was deemed 180 days regardless of grading potential.

All steers were transported to a commercial packing plant and slaughtered under normal procedures. Hot carcass weights were obtained at the time of slaughter. Additional carcass data were obtained 48 hours postmortem. Adjusted fat thickness, ribeye area and kidney, heart and pelvic fat percentage were obtained and used to calculate yield grade. Forty-eight hour marbling scores, quality grade, skeletal maturity, lean maturity and overall maturity scores were also assigned to individual carcasses. Distribution and texture scores were given for marbling; color, firmness and texture scores were appraised for the longissmus muscle. The left side of each carcass was used for compositional and sensory data.

Sixth through the twelfth wholesale ribs (IMPS 103) were removed from each carcass, vacuum packaged and transported to Oklahoma State University Meats Laboratory for further analysis. In addition, a .25 inch slice of each ribeye was removed, frozen, packed in dry ice and shipped to the Texas A & M University Meat and Muscle Biology Laboratory for cholesterol analysis.

Table 1. Feedlot rations nutrient composition

Ration numbers	1	2	3	4
Days fed	1-7	8-15	16-23	24-finish
% Concentrate	50	65	80	90
Mcal/cwt	74	80	85	90
NEm, NEg, Mcal/cwt	45	50	55	60
% Crude protein	12.0	11.0	10.0	9.50
% Calcium	.73	.63	.57	.53
% Phosphorus	.36	.29	.28	.24

At the Oklahoma State University Meats Laboratory, 9-10-11th rib sections were removed from the IMPS 103 rib. Physical separation of the 9-10-11th rib involved subcutaneous fat, seam fat, muscle, other soft tissue, and bone plus ligamentum nuchea removal. Chemical analysis of the soft tissue as well as .25 inch slice of the longissimus muscle was conducted. Ether extractable lipid and moisture determinations for each sample were obtained and used in conjunction with the physically separated components to determine the percentages of subcutaneous, intermuscular and intramuscular fat, as well as percentage of fat-free muscle, and bone for the 9-10-11th rib cuts.

Two 1.0 inch thick steaks were obtained from the longissimus muscle starting at the 12th rib end, vacuum packaged and frozen (-22°F) for subsequent taste panel evaluation and Instron shear tests. Each pair of steaks was removed from the freezer, thawed (36°F) and broiled on Farberware Open-Hearth broilers to an internal temperature of 158°F. Samples of one cooked steak were evaluated by a six member, trained sensory panel. Panelists individually scored samples from each steak for juiciness, ease of fragmentation, amount of connective tissue, overall tenderness, flavor intensity and off-flavor using eight-point, descriptive rating scales (8= extremely juicy, etc.). The second steak from each rib cut was cooled to 77°F and six .5 inch cores were removed parallel to the longitudinal orientation of the muscle fibers, for Instron shear force measurements. An average shear force value based on a minimum of six cores was recorded for each steak.

Results and Discussion

Growth Traits

Charolais-sired and Simmental-sired crossbred calves were larger framed than the other breed types upon entrance to the feedlot (Table 2). All other breed types had an average frame score of 4, suggesting that they should weigh 1050 - 1150 lb when they reach approximately .5 in of fat thickness over the rib.

During the 14 day warm-up period, the Brahman crossbred steers gained 5.5 lbs per day. The Charolais-sired and Simmental-sired crossbred calves were freshly weaned and transported to the feedlot; therefore, they lost weight.

Average daily gain performance among all breed types exceeded 3.0 lb per day during the 148-day test.

Angus, Brahman crossbred, Hereford and Angus x Hereford steers were perceived to have reached adequate fat deposition to slaughter after 148

Table 2. Least squares means for growth traits.

Trait	Breed group A[a]	B	C	H	L	S	AXH
Hip ht(in)	44.4[bc]	45.2[cd]	47.8[e]	44.2[b]	45.5[d]	46.1[d]	44.0[b]
Frame score	4.1[b]	4.2[b]	6.0[d]	4.0[b]	4.8[c]	5.7[d]	3.9[b]
In wt (lb)	637[d]	571[b]	700[e]	576[b]	593[bc]	573[b]	621[cd]
14d wt (lb)	654[d]	648[d]	668[cd]	614[c]	634[cd]	560[b]	693[e]
ADG1 (lb/d)	1.2[c]	5.5[d]	-2.3[b]	2.7[c]	2.9[c]	-0.9[b]	5.1[d]
162d Wt (lb)	1137[b]	1102[b]	1194[cd]	1147[bc]	1113[b]	1113[b]	1217[d]
ADG for 148 day	3.2[b]	3.1[b]	3.5[c]	3.6[c]	3.2[b]	3.7[c]	3.5[c]
176d Wt (lb)			1220[c]		1136[b]	1155[bc]	
ADG for 162 day			3.4[bc]		3.1[b]	3.7[c]	

[a]A = Angus, B = Brahman crossbreds, C = Charolais-sired crossbreds, H = Hereford, L = Limousin-sired crossbreds, S = Simmental-sired crossbreds and AXH = Angus x Hereford.

b,c,d,e Means on the same row bearing a common superscript are not different (P>.05).

days on test. The Continental crossbred steers were somewhat leaner and were fed an additional 14 days prior to slaughter to increase their external fat deposition and possibly enhance their probability of attaining the choice quality grade.

All cattle attained acceptable live weights prior to slaughter. A potential problem might exist if the smaller framed cattle finished too quickly, especially since they were placed into the feedlot upon weaning. However, all cattle produced carcasses in the 600 to 800 lb desirable weight range requested by the packing and retailing industry (Table 3).

Carcass Traits

Charolais-sired, Limousin-sired and Simmental-sired crossbred calves were leaner, heavier muscled and higher cutability cattle as compared to

Table. 3 Least squares means for carcass traits

Trait	Breed group						
	A[a]	B	C	H	L	S	AXH
Dressing %	61.5^{d}	61.0^{cd}	63.7^{e}	60.2^{cd}	64.5^{e}	61.2^{d}	59.3^{c}
Hot carcass wt (lb)	698^{cde}	671^{c}	777^{f}	689^{cd}	732^{e}	707^{de}	720^{de}
Fat thickness (in)	$.57^{ef}$	$.46^{de}$	$.22^{c}$	$.55^{ef}$	$.38^{d}$	$.33^{cd}$	$.61^{f}$
Ribeye area (sq in)	11.6^{cd}	10.9^{c}	15.5^{f}	11.5^{cd}	13.6^{e}	12.0^{d}	11.3^{cd}
REA/100 lb carcass wt	1.66^{cd}	1.62^{c}	1.99^{f}	1.67^{cd}	1.85^{e}	1.70^{d}	1.57^{c}
Quality grade	Ch^{-e}	Sel^{0cd}	Sel^{0cd}	Sel^{+e}	Sel^{0de}	Sel^{-c}	Ch^{-e}
Yield grade	3.1^{e}	3.2^{e}	1.4^{c}	3.2^{e}	2.3^{d}	2.4^{d}	3.6^{e}

[a]A = Angus, B = Brahman crossbred, C = Charolais-sired crossbreds, H = Hereford, L = Limousin-sired crossbreds, S = Simmental-sired crossbreds and AXH = Angus x Hereford.

[b]Sel^{-} = Low select, Sel^{0} = Average select, Sel^{+} = High select Ch^{-} = Low choice.

c,d,e,f Means on the same row bearing a common superscript are not statistically significant (P>.05).

other breed groups (P<.05, Table 3). Angus, Angus x Hereford and Hereford calves had higher quality grade scores, but at the same time were appreciably fatter and had lower ratios of lean to fat.

During the past 30 months, the beef industry has benefitted greatly by the trimming of excessive fat from the product prior to going into the retail meat case. The consumer does not want waste fat. Retailers nation-wide have accepted consumer signals and today most fresh beef sold at retail is trimmed to .25 inch or less of external fat. The Angus, Brahman crossbred, Hereford and Angus x Hereford had external fat levels that compare to current industry averages. However, a reduction in external fat while maintaining marbling would be desirable. Possibly if the cattle were of a larger frame score upon entrance to the feedlot, they would have been leaner at slaughter.

The packing and retailing industries currently recognize the acceptable range for ribeye area to be from 12 to 15 sq in. This range translates into approximately 1.8 to 2.0 sq in of ribeye area per hundred lb of carcass weight. EXCEL Corporation has developed a system to classify and score cattle according to their potential retail yields. Table 4 shows the EXCEL scoring

Table 4. EXCEL muscle scoring system.

Muscle score	External fat thickness	Area of ribeye muscle/cwt carcass
A-1	.35 inch or less	2.0 inches/cwt or more
A-2	.36 to .45 inch	1.8 to 1.99 inches/cwt
B-3	.46 to .60 inches	1.70 to 1.79 inches/cwt
C-4	.61 to .80 inches	1.40 to 1.69 inches/cwt
C-5	.80 inches or more	Less than 1.4 inches/cwt

system as it relates to external fat thickness and ribeye area per hundred lb of carcass weight. A-1's and A-2's are the most desirable cattle, B-3's are average cattle and C-4's and C-5's are inferior from a retail yield standpoint. The Charolais-sired and Limousin-sired crossbred calves were A-2's, Simmental-sired crossbred B-3's and other breed types C-4's according to the EXCEL system. This scoring system indicates that the Angus, Hereford, Angus x Hereford and Brahman crossbred calves were excessively fat and too low in cutability. Short supplies of feeder and slaughter cattle have prevented substantial price/value differentiation among live cattle. However, as supply situations are corrected, it is important for the producers to realize packer intentions to severely discount wasty, light muscled cattle.

As long as the current pricing system continues to discount select carcasses, the quality grade target for retail beef will continue to be choice. Marbling at higher levels tends to reduce variation in palatability of today's beef and keep the retail product in an acceptable category from a consumer standpoint. Angus and Angus x Hereford steers were the only breed groups to reach the choice quality grade. Marbling is a genetically inherited trait. We need to identify cattle that will transmit desirable levels of marbling to their offspring while at the same time reducing the level of external waste.

Table 5 presents the physical and chemical composition of the 9-10-11th rib section of all breed types. Percentage of muscle from the 9-10-11th rib

Table 5. Least squares means for 9-10-11th rib composition.

Trait	Breed group A[a]	B	C	H	L	S	AXH
Muscle %	46.6[b]	46.6[b]	58.5[d]	46.8[b]	50.2[c]	50.2[c]	43.9[b]
Fat %	37.4[cd]	37.4[cd]	25.5[b]	37.9[cd]	34.8[c]	32.5[c]	40.5[d]
Bone %	14.9[bc]	14.9[bc]	15.6[cd]	15.0[bc]	14.2[b]	16.6[d]	15.6[cd]

[a]A = Angus, B = Brahman crossbred, C = Charolais-sired crossbreds, H = Hereford, L = Limousin-sired crossbreds, S = Simmental-sired crossbreds and AXH = Angus x Hereford.

[b,c,d]Means on the same row bearing a common superscript are not statistically significant (P>.05).

cuts was inversely related to the percentage of total fat in the rib section; whereby, Charolais-sired crossbred calves had leaner, heavier muscled rib sections and Angus x Hereford steers had fatter, lighter muscled rib sections. Intramuscular fat percentage (marbling) was greatest for Angus steers which indicates that the Angus breed has a distinct advantage in marbling ability.

Taste Panel Evaluation and Instron Shear Force

Sensory panel evaluation of cooked steaks indicated few differences between breed types (Table 6). Most traits had mean sensory ratings well within the acceptable range of 4.5 or greater (off-flavor greater than 3.5). Instron shear values for the respective breed types did not correspond

Table 6. Least squares means for sensory panel evaluation and shear force.

Trait	Breed group						
	A[a]	B	C	H	L	S	AXH
Juciness[a]	5.06^{e}	4.43^{cd}	4.18^{c}	4.66^{cde}	4.95^{cde}	4.55^{cde}	4.88^{d}
Ease of fragmentation[a]	5.66^{c}	5.99^{c}	5.33^{c}	5.69^{c}	5.62^{c}	5.58^{c}	5.80^{c}
Connective tissue[a]	6.22^{de}	6.18^{de}	5.54^{c}	6.24^{de}	5.87^{cd}	5.65^{c}	6.37^{e}
Flavor intensity[a]	5.19^{f}	4.64^{c}	4.87^{cde}	5.07^{ef}	4.82^{cd}	5.00^{def}	4.81^{cd}
Overall tenderness[a]	5.75^{de}	6.15^{e}	5.18^{c}	5.89^{de}	5.80^{de}	5.38^{cd}	5.83^{de}
Off flavor[b]	3.75^{c}	3.93^{c}	3.78^{c}	3.93^{c}	3.92^{c}	3.67^{c}	3.90^{c}
Shear force, lb.	11.62^{e}	8.94^{c}	9.33^{c}	9.77^{cd}	9.96^{cd}	9.77^{cd}	11.37^{de}
Cooking time (minute)	16.67^{c}	18.00^{cd}	19.50^{de}	19.83^{de}	20.00^{de}	20.33^{e}	18.50^{cde}
Cooking loss %	22.93^{c}	26.81^{d}	25.27^{cd}	26.01^{cd}	25.22^{cd}	27.36^{d}	26.01^{cd}

[a]means based on 8-point rating scales (8 = extremely juicy, easy to fragment, low in connective tissue, intense flavor, tender; 1=extremely dry, difficult to fragment, abundant connective tissue, bland flavor, tough).

[b]means based on 4-point rating scale (4 = none; 3 = slight; 2 = moderate; 1 = intense).

c,d,e,f means on the same row bearing a common superscript are not statistically significant (P>.05).

directly with expected tenderness projections based on quality grades (i.e. Angus = 8.94/Ch^{-}, percentage Brahman-x = 9.33/Sel^{0}, Simmental-x = 11.37/Sel^{-}, Angus x Hereford = 11.62/Ch^{-}). The latter finding is supportive of numerous research publications regarding select and choice tenderness comparisons among cattle with more than .3 in of fat thickness and 100 days or more of high concentrate feeding.

Cholesterol Analysis

The cholesterol content of raw beef longissimus muscles revealed few differences attributable to breed type. The mean cholesterol content was 59.14 mg/100 grams of raw steak while the standard deviation was 6.14 mg/100 grams of raw steak. It appears, based on current industry practices and the information obtained in this study, that the variation in cholesterol is not large enough to allow for the selection of low cholesterol beef due to breed type.