Heterosis and Breed Effects for Beef Traits of Brahman Purebred and Crossbred Steers

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Brahman heterosis (with two *Bos taurus* breeds) for important carcass traits in the U.S. beef industry was large and beneficial for most traits. Traits related to beef quality and palatability still have room for improvement in Brahman straightbreds and crosses.

Summary

Heterosis was documented for traits that are important in the determination of value for beef carcasses in the United States. Brahman-Angus carcasses had very high levels of heterosis for live weight, hot carcass weight, adjusted 12th rib fat thickness, longissimus area, and USDA yield grade. Estimates of heterosis for the Criollo breed Romosinuano were lower than Brahman-Angus heterosis. Brahman direct effects were to increase live weight, hot carcass weight, adjusted 12th rib fat thickness, longissimus area, and USDA yield grade. However, generally consistent with previous reports, Brahman sire and dam breed means for marbling score, sensory panel overall tenderness, and % carcasses grading Choice were lower than Bos taurus breeds; Warner-Bratzler shear force values for Brahman were higher. Angus-Romosinuano means for live weight, hot carcass weight, adjusted 12th rib fat thickness, longissimus area, and USDA yield grade were very similar to those raised on the Great Plains (Wheeler et al., 2010). Neither Brahman-Romosinuano nor Angus-Romosinuano steers had any advantages for these traits as compared to Brahman-Angus. Brahman-Angus crossbred steers were projected to reach all end points (hot carcass weight, 12th rib fat thickness, or marbling score) sooner than most other breed groups.

Introduction

Since Brahman crossbred cows are so widely used by cow-calf producers in the Southern United States, producer profitability is often affected by the carcass value of the resulting steers from matings to obtain crossbred Brahman cows. The reputation for inadequate carcass quality and tenderness for both Brahman purebreds and crossbreds results in lower prices paid at various places in the beef production system for calves with visible Brahman inheritance. *Bos taurus* Criollo breeds, such as the Romosinuano of Colombia may offer an alternative to Brahman, or a complement to Brahman, and result in adapted females that could be used in cow-calf production and in steers that may perform adequately in U.S. feeding and beef production traits. Romosinuano cattle were available for a crossbreeding project to investigate such issues at the Subtropical Agricultural Research Station in Brooksville. The objectives of this work were to estimate heterosis and breed genetic effects for traits affecting carcass value and beef palatability traits from purebred and crossbred steers produced by Brahman, Angus, and Romosinuano cattle.

Procedure

Brahman, Angus, and Romosinuano bulls were mated to cows of the same breeds in all combinations. Straightbred (3 groups) and crossbred (6 groups; reciprocal F_1s were considered to be distinct groups) steers were spring-born in 2002, 2003, and 2004 (n = 137, 148, and 179 steers, respectively). Steers were weaned at approximately 7 mo of age in September of each year in three separate wk. A total of 11 Brahman, 12 Angus, and 16 Romosinuano bulls sired steers with records in these data (average of 13, 14, and 10 steers per sire, respectively).

Approximately one mo after weaning, in mid-October of each year, steers were transported by semi-trailer to the Grazinglands Research Laboratory (GRL) at El Reno, Oklahoma. After a short receiving period, they were assigned to two management groups and placed on winter

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wheat pasture until the first week of May in the subsequent year. Each year, the heaviest 10 steers from each breed group were assigned in pairs to GRL feeding pens (n = 15; 6 steers per pen). Assignments were made so that pairs of steers from each breed group were penned at least once with pairs of steers from every other breed group. Those steers that then remained were then assigned to larger feeding pens (4 pens in two of the project years, 6 pens in the final project year; n = 12 to 16 steers per pen).

One third of the steers in each pen and breed group was randomly assigned to each of three harvest dates in August, September, and October of each year, which corresponded to averages of 101, 129, and 157 d fed across the three project years. Steers were transported approximately 5 h to Amarillo, TX, for commercial harvest.

Traits analyzed included those that affect USDA yield and quality grades, and assessments of palatability. Hot carcass weight was obtained from harvest facility records, and was used in conjunction with final live weight (shrunk weight prior to transportation) to estimate dressing percentage. After chilling for approximately 18 to 24 h, trained personnel measured fat thickness, longissimus area, marbling score (100 to 199 = Devoid; 200 to 299 = Traces; 300 to 399 = Slight; 400 to 499 = Small; 500 to 599 = Modest; 600 to 699 = Moderate), and USDA quality grade at the 12th-13th rib interface on each carcass. The left strip loin from each carcass was obtained and fabricated into 1-in thick steaks for palatability analyses. The 3 most anterior steaks from the strip loin were obtained and aged 7 d. They were vacuum-packaged and transported frozen to the University of Florida for shear force and sensory panel evaluation. Steaks were randomly designated for Warner-Bratzler shear force and sensory panel evaluations. Peak shear force was measured on 6 to 8 cores per steak that were 0.5 inches in diameter using a Warner-Bratzler shearing device, and analyzed as the average of those values. Cooked loin steaks were cut into 0.5-in^2 samples and served warm to an 8- to 10-member trained sensory panel, and were evaluated for juiciness, flavor intensity, panel tenderness, and detectable amount of connective tissue on scales from 1 to 8 (1 = extremely dry, extremely bland, extremely tough, abundant amount; 8 = extremely juicy, extremely intense, extremely tender, none detected). Off flavor of steak samples was evaluated on a scale from 1 to 6 (1 = extreme off flavor; 6 = no off flavor detected). Sensory traits were analyzed as the average of panelists' responses.

Since serial harvest was conducted, average values for hot carcass weight, adjusted 12th rib fat thickness, and marbling score (712 lb, 0.5 in, and Small^{06}, respectively), the average days fed (130), and the average regression of traits on days fed across all breed groups for these traits were used to estimate the number of feeding days required for each breed group to reach the end points above (carcass weight, adjusted 12th rib fat thickness, and marbling score). These methods have been described in detail and used for over 30 years (Koch et al., 1976; Wheeler et al., 1996; 2001; 2010).

Results

In general, crossbred steers were projected to require fewer days on feed to the different end points (Table 1). Angus steers were projected to require fewer days on feed to achieve fat-based endpoints than other breed groups. Brahman-Angus steers were also projected to require fewer days to reach 12th rib fat thickness and marbling score end points. As expected, Brahman steers were projected to require the most days to achieve any of the three end points. Brahman-Romosinuano crosses were projected to require similar feeding time to reach a marbling score end point, but there appeared to be reciprocal differences within the Brahman-Romosinuano crosses for the other end points.

When comparing crossbred steers, breed group was not influential on marbling score, percentage grading Choice or Standard, Warner-Bratzler shear force, or sensory panel tenderness, and connective tissue amount, but sire and dam breeds as main effects were detected. Angus sire breed means (Table 2) were greater than Brahman sire breed means for marbling score, percentage grading Choice, sensory panel tenderness (which indicated more tender steaks), and connective tissue amount

(lower amounts). Angus sire breed means were lower than Brahman for Warner-Bratzler shear force and percentage grading Standard. Romosinuano had a lower marbling score sire breed mean than Angus, but did not otherwise differ from Angus for these traits. Romosinuano sire breed means were greater than Brahman for sensory panel tenderness and connective tissue amount, and were lower than Brahman for percentage grading Standard. Results and differences of dam breed means were very similar to those for sire breed means (Table 2).

The heterosis estimates for Brahman-Angus for all 7 traits were of greater magnitude than corresponding Romosinuano estimates (Table 3). Heterosis was detected for live weight, hot carcass weight, dressing percentage, and longissimus area for Brahman with Romosinuano and Angus with Romosinuano. Brahman-Romosinuano heterosis (9.5 to 15.6%) was also detected for 12th rib fat thickness and yield grade. It should be noted that heterosis for yield grade was undesirable, that is, crossbreds had greater numerical yield grades than straightbreds.

The estimated Brahman direct effects were to increase live weight, hot carcass weight, dressing percentage, and yield grade (Table 3). Angus direct effects were to increase live weight, hot carcass weight, 12th rib fat thickness, longissimus area, and yield grade. The estimated Romosinuano breed direct effects were to lower live weight, hot carcass weight, dressing percentage, 12th rib fat thickness, and yield grade. Maternal breed effects were detected for Brahman and Romosinuano for most of these traits; however, they were of opposite numerical sign than direct effects.

Literature Cited

Koch et al. 1976. J. Anim. Sci. 43:48.
Wheeler et al. 1996. J. Anim. Sci. 74:1023.
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Table 1. Numbers of steers and estimates of days of feeding needed for steers in breed groups to reach these end points: Fat thickness (0.5 in), hot carcass weight (712 lb), and marbling score (406; Small[06])

		End point[2]		
Breed Group[1]	N	Fat thickness	Hot carcass weight	Marbling score
BB	47	163	164	223
RR	72	170	155	148
AA	38	93	140	54
RB	36	170	163	180
BR	73	113	93	179
RA	41	129	137	100
AR	77	116	96	97
BA	34	76	83	115
AB	45	115	109	126

[1]Breed group designation: the first and second letters in a pair indicate the breed of sire and dam, respectively for the steers in that group B = Brahman, A = Angus, and R = Romosinuano.
[2]For example, Romosinuano steers would require an estimated 170 days to reach an average of 0.5 in fat thickness.

Table 2. Sire and dam breed means for beef quality traits and palatability traits of steaks

Breed	Marbling[2]	Choice, %	Standard, %	Shear force, lb	Tenderness[3]	Connective Tissue[3]
Sire breed						
Brahman	359.8[b]	31.0[b]	23.1[b]	9.7[b]	5.4[b]	6.1[b]
Angus	475.2[a]	75.0[a]	5.0[a]	8.6[a]	5.8[a]	6.5[a]
Romosinuano	393.1[b]	46.3[ab]	10.0[a]	9.3[ab]	5.8[a]	6.5[a]
SE[1]	11.1	4.9	2.7	0.3	0.08	0.07
Dam breed						
Brahman	351.5[c]	30.9[c]	29.0[b]	9.7[b]	5.5[b]	6.2[b]
Angus	480.5[a]	73.6[a]	2.0[a]	8.8[a]	5.7[a]	6.4[ab]
Romosinuano	396.1[b]	47.8[b]	7.1[a]	9.0[ab]	5.8[a]	6.5[a]
SE	9.4	4.3	2.9	0.2	0.07	0.06

[1]Standard errors were averaged across breed groups within traits.
[2]Marbling score: 300 to 399 = Slight; 400 to 499 = Small; 500 to 599 = Modest.
[3]Tenderness and detectable amount of connective tissue measured on scales from 1 to 8: 1 = extremely tough, abundant amount; 8 = extremely tender, none detected.
[a,b,c]Within a column and breed group, means that without a common superscript differ ($P<0.05$).

Table 3. Estimates of genetic effects for carcass traits

	Live weight, lb	Hot carcass weight, lb	Dressing percentage	Fat thickness, in	LMA[5], in^2	Yield grade
Heterosis[1]						
BA[3]	135.8	102.1	1.7	0.1	0.82	0.4
	12.4%	15.1%	2.7%	19.9%	7.1%	13.6%
BR	81.4	57.3	0.6	0.06	0.39	0.3
	7.6%	8.6%	1.0%	15.6%	3.3%	9.5%
AR	71.2	55.6	1.1	[2]	0.56	
	6.4%	8.1%	1.7%		4.5%	
SE[4]	14.1	10.1	0.3	0.02	0.186	0.08
Direct effects						
B	75.0	63.5	1.6			0.6
A	72.8	42.3		0.15	0.67	0.3
R	–147.7	–106.0	–1.4	–0.21		–0.9
SE	36.2	23.4	0.6	0.04	0.39	0.13
Maternal effects						
B	–113.5	– 89.5	–1.6	–0.16		–0.7
A				0.06		
R	136.2	100.8	1.5	0.09	0.50	0.5
SE	21.2	13.5	0.4	0.03	0.217	0.09

[1]Heterosis estimates are presented in units of each trait, and as % of purebred average
[2]Empty cells indicate estimates that did not statistically differ from 0.
[3]B = Brahman; A = Angus; R = Romosinuano.
[4]Standard errors are averages within effects within traits.
[5]LMA = Loin muscle area (longissimus at the 12th and 13th rib).