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# Feedlot Performance, Carcass Traits, and Palatability Traits of Hereford and Hereford × Brahman Steers<sup>1</sup>

J. A. Sherbeck, J. D. Tatum<sup>2</sup>, T. G. Field, J. B. Morgan, and G. C. Smith

Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523

**ABSTRACT:** Short-yearling steers of known genotypes—straightbred Hereford (100H, n = 80) 75% Hereford × 25% Brahman (75H:25B, n = 80), and 50% Hereford × 50% Brahman (50H:50B, n = 80)—were sampled serially at four time-on-feed endpoints (84, 98, 112, 126 d) to compare feedlot performance and carcass and palatability traits of Hereford and Hereford × Brahman steers. After slaughter, USDA yield grade and quality grade factors were recorded, and a portion of the longissimus muscle was removed from the left side of each carcass and fabricated into four 2.54-cm steaks for palatability analyses. Paired steaks from each carcass were aged (6 and 18 d after death), and sensory panel and shear force evaluations were performed. At a constant live weight, 100H steers had higher ADG and produced less mature

carcasses with smaller longissimus muscle areas and higher marbling scores than did 75H:25B and 50H:50B steers. The 50H:50B steers had the highest ( $P < .05$ ) values for dressing percentage. Loin steak tenderness and juiciness decreased ( $P < .05$ ) and shear force values increased ( $P < .05$ ) as the percentage of Brahman breeding increased. Extending the postmortem aging period from 6 to 18 d improved shear force values by 20% and panel tenderness ratings by approximately 14%. Beef from steers of the three breeds responded similarly to aging. When Certified Hereford Beef (CHB) specifications were applied, steaks from 100H steers and 75H:25B steers had similar shear force values, suggesting that beef from quarter-blood Brahman crossbred steers could be included in the CHB Program without detrimental effects on product tenderness.

Key Words: Beef, Brahman, Feedlots, Carcass, Palatability, Tenderness

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## Introduction

Beginning in 1990, the American Hereford Association (AHA) commissioned a series of studies to characterize carcass and beef palatability traits of Hereford straightbred and crossbred cattle. Results of these studies (Huffhines, 1992; Ledall, 1993) suggested that either straightbred or crossbred Hereford cattle could be used to produce steaks that would meet the American Heart Association's guidelines for less than 30% of total calories from fat (when external fat is removed) and, at the same time, have palatability characteristics similar to those of steaks produced by

U.S. Choice carcasses. These findings were used by the AHA as the basis for the development of a new, branded beef program—Certified Hereford Beef (Huffhines, 1993).

Several concerns still exist, however, regarding the use of Brahman crossbred cattle to supply beef products for this new program. Previous research consistently has shown that beef tenderness decreases, almost linearly, as the proportion of Brahman breeding increases (Damon et al., 1960; Palmer, 1963; Peacock et al., 1982; Crouse et al., 1989; Johnson et al., 1990). As a result, cattle with any visually discernible evidence of Brahman ancestry often are excluded completely from other branded beef programs (e.g., Certified Angus Beef).

The objective of the present study was to compare feedlot performance, carcass traits and beef palatability characteristics of straightbred Hereford (**100H**), 75% Hereford × 25% Brahman (**75H:25B**), and 50% Hereford × 50% Brahman (**50H:50B**) steers and to determine whether steers with 25% or 50% Brahman breeding could be included in the Certified Hereford Beef (**CHB**) Program.

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<sup>2</sup>To whom correspondence should be addressed.

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## Materials and Methods

**Animals.** Two hundred forty 11- to 12-mo-old steers of known breed percentages (100H, 75H:25B, and 50H:50B) were identified for use in this study by official representatives of the AHA and the American Brahman Breeders Association (ABBA). Breed association representatives were asked to provide 20 steers from each of four separate producers to represent each breed group. However, only a few sources of crossbred steers with known percentages of Hereford and Brahman breeding could be identified. The 100H steers were supplied by DaShiell Herefords (Eltopia, WA) (n = 20); Jeff Lord (Boise, ID) (n = 20); MacKenzie Ranch (Baker City, OR) (n = 20); and Monahan Cattle Co. (Hyannis, NE) (n = 20). Steers (n = 80) in the 75H:25B group were provided by Steve Mafridge (Houston, TX), and cattle in the 50H:50B group were supplied by Steve Mafridge (n = 40) and U.S. Cattle (Winona, MS) (n = 40). Forty of the 50H:50B steers were sired by Hereford bulls mated to Brahman cows, and 40 were sired by Brahman bulls mated to Hereford cows. Cattle supplied by Jeff Lord and MacKenzie Ranch had been placed in a backgrounding lot and fed a grower diet, for a brief period, before the study. All other cattle had been grazed on native pasture before procurement. Representatives of the AHA and the ABBA considered the study steers to be representative of the United States population of commercial straightbred Hereford and Hereford × Brahman crossbred yearling feeder steers. Specific pedigree information, such as individual sire identification and the similarity of Hereford ancestry among the breed groups, was not available.

**Processing.** The steers were transported from their points of origin to Miller Feedlot near LaSalle, CO. Within 2 d of their arrival at the feedlot, the steers were individually identified (using uniquely numbered plastic ear tags and metal ear clips), vaccinated with bovine rhinotracheitis-virus-diarrhea-parainfluenza-3-respiratory syncytial virus vaccine (IBR-PI<sub>3</sub>, Sanofi Animal Health, Overland Park, KS), and implanted with a single implant containing 20 mg of estradiol benzoate and 200 mg of progesterone. Also, each steer was weighed and measured to determine hip height. After processing, each steer was visually scored by four experienced evaluators who independently scored each steer for frame size (USDA, 1979), muscling (USDA, 1976), and condition (Tatum et al., 1986). Visual scores were averaged to provide a single score for each steer. After scoring, the steers were penned, by breed group, and allowed 2 wk to become acclimated. Before initiation of the finishing period, steers in each breed group were stratified by weight within producer group (using the weight recorded at the time of processing) and assigned randomly to one of four days-on-feed groups (84, 98, 112, or 126 d).

The procedure used to assign steers to days-on-feed groups resulted in equal producer representation and a uniform distribution of beginning weights within each group.

**Finishing.** Individual on-test weights were recorded and the steers were finished on a diet consisting of 77.7% rolled corn, 17.0% corn silage, 5.3% protein supplement, and 1,000 IU·steer<sup>-1</sup>·d<sup>-1</sup> of a vitamin E supplement. Four steers were eliminated from the study, during finishing, because of chronic illness. Interim live weights were obtained every 28 d during the finishing period, and off-test weights (full) were obtained on the day before slaughter. Weights were obtained at approximately the same time on each weigh date.

**Slaughter, Carcass Evaluation, and Sample Procurement.** On the morning of each designated slaughter date, steers in each days-on-feed group were transported to the Monfort/ConAgra beef processing facility in Greeley, CO, where they were slaughtered using conventional commercial procedures. Identity of each carcass was maintained throughout the slaughter process. Immediately before entering the chill cooler, split sides were weighed and electrically stimulated. The carcass sides contacted a series of four electrodes as they moved along the rail. The electrodes were set to deliver a continuous current (60 Hz; 20, 30, 40, and 50 V, respectively) for 2 s (contact time), with a 2 s interval between electrodes (non-contact time). During the first few hours of the chill period, the air temperature of the cooler was reduced to -2°C. Then at 20 h after death, the cooler temperature was increased to 1°C for the last 4 h of the chilling period. For the first 8 h of the chill period, the carcasses were sprayed intermittently (2 min on, 8 min off) with a fine mist of 2°C water. Approximately 24 h after death, carcasses were ribbed (between the 12th and 13th ribs) and placed on a single rail in the sales cooler for carcass data collection. The same official of the Meat Grading and Standardization Branch of AMS-USDA evaluated each carcass, and factors used to determine USDA yield grades (measured fat thickness, adjusted fat thickness, longissimus muscle area, hot carcass weight, and estimated percentage of kidney, pelvic, and heart fat) and quality grades (lean maturity, skeletal maturity, and marbling score) were recorded (USDA, 1989).

After carcass grade data had been collected, a section of the longissimus muscle (extending caudally from the last thoracic vertebra to the 2nd lumbar vertebra) was removed from the short loin on the left side of each carcass. The loin samples were transported to the Colorado State University Meat Laboratory, where they were fabricated to yield four steaks (2.54 cm thick with 3 mm external fat) for palatability determinations. Two loin steaks were chosen at random, vacuum-packaged, and aged (at 2°C) until the 6th d after death. The remaining two loin steaks

Table 1. Least squares means and residual standard deviations for initial feeder cattle traits

Effect	n	Weight at processing, kg	Hip height, cm	Visual score <sup>a</sup>		
				Frame size	Muscling	Condition
Overall mean	236	327.0	123.6	5.6	4.3	3.9
Breed group						
100H	77	334.6 <sup>b</sup>	122 <sup>d</sup>	5.6 <sup>c</sup>	4.6 <sup>b</sup>	4.5 <sup>b</sup>
75H:25B	80	319.0 <sup>c</sup>	124 <sup>c</sup>	5.4 <sup>d</sup>	4.0 <sup>c</sup>	3.5 <sup>d</sup>
50H:50B	79	327.6 <sup>b</sup>	125 <sup>b</sup>	5.8 <sup>b</sup>	4.4 <sup>b</sup>	3.8 <sup>c</sup>
Producer (breed)						
1 (100H)	18	337.6 <sup>c</sup>	125 <sup>bc</sup>	6.3 <sup>b</sup>	4.5 <sup>bc</sup>	4.2 <sup>cd</sup>
2 (100H)	19	338.8 <sup>c</sup>	119 <sup>f</sup>	4.8 <sup>e</sup>	4.7 <sup>b</sup>	5.1 <sup>b</sup>
3 (100H)	20	357.7 <sup>b</sup>	122 <sup>de</sup>	5.8 <sup>c</sup>	4.7 <sup>b</sup>	4.5 <sup>c</sup>
4 (100H)	20	304.6 <sup>e</sup>	121 <sup>ef</sup>	5.4 <sup>d</sup>	4.6 <sup>b</sup>	4.2 <sup>cd</sup>
5 (75H:25B)	80	319.0 <sup>d</sup>	123 <sup>cd</sup>	5.4 <sup>d</sup>	4.0 <sup>d</sup>	3.5 <sup>e</sup>
5 (50H:50B)	40	341.3 <sup>c</sup>	127 <sup>b</sup>	5.8 <sup>c</sup>	4.7 <sup>b</sup>	4.1 <sup>f</sup>
6 (50H:50B)	39	313.9 <sup>de</sup>	124 <sup>c</sup>	5.9 <sup>c</sup>	4.1 <sup>cd</sup>	3.6 <sup>e</sup>
Residual SD <sup>g</sup>	—	27.1	3.12	.60	.66	.55

<sup>a</sup>Frame size: 1 = small-, 2 = small, 3 = small+, 4 = medium-, 5 = medium, 6 = medium+, 7 = large-, 8 = large, 9 = large+. Muscle thickness: 1 = thin-, 2 = thin, 3 = thin+, 4 = medium-, 5 = medium, 6 = medium+, 7 = thick-, 8 = thick, 9 = thick+. Condition: 1 = very thin, 2 = moderately thin, 3 = slightly thin, 4 = average, 5 = slightly fleshy, 6 = moderately fleshy, 7 = very fleshy.

<sup>b,c,d,e,f</sup>Means in the same column, within an effect, having a common superscript letter do not differ ( $P > .05$ ).

<sup>g</sup>Standard error of least squares means may be calculated as  $1/\sqrt{n} \times \text{residual SD}$  for a trait, where n = number of steers in that particular subclass.

were vacuum-packaged and aged (at 2°C) until the 18th d after death. When specified aging periods had been completed, the steaks were frozen and stored at -10°C.

**Sensory Evaluation and Shear Force Determinations.** Paired loin steaks were removed (in random order) from frozen storage and allowed to thaw for 20 to 22 h in a refrigerated area (2°C). Thawed steaks were broiled on Farberware grills to an internal temperature of 70°C. Cubed samples (1 × 2 × 2.5 cm) of one cooked steak from each animal were served warm to a six-member, trained sensory panel (Cross et al., 1978) in groups of eight samples. Panelists scored the samples for juiciness, tenderness, and flavor intensity using 8-point, structured rating scales (AMSA, 1978). The remaining steak was allowed to cool to room temperature and six core samples (1.27 cm in diameter) were removed parallel to the muscle fiber orientation. Each core sample was sheared twice using a Warner-Bratzler shear machine. The resulting 12 shear force values were recorded and averaged to obtain a single shear force value for each steak.

**Statistical Methods.** Least squares analyses were performed using the GLM procedure of SAS (1985). Data for feeder cattle traits were analyzed using a least squares model that included the fixed effects of breed and producer nested within breed. The least squares model used for analyses of feedlot performance traits and carcass traits included the effects of breed, producer within breed, and off-test weight as a covariate. Palatability data were analyzed using a repeated measures model that included the fixed

effects of breed, producer within breed, days-on-feed (partitioned into linear, quadratic, and cubic effects), the breed × days-on-feed interaction, and postmortem aging time (6 vs 18 d) as a repeated measure. All tests of significance were computed using the within plus residual error mean square. When  $F$ -tests were significant, least squares means were compared using LSD tests. For certain group comparisons, frequency data were tested for significance using chi-square tests.

## Results and Discussion

**Feeder Steer Traits.** Least squares means for traits used to characterize the yearling feeder steers in this study are presented in Table 1. Weight at processing differed ( $P < .05$ ) among breed groups and among producer groups within breed. Differences in initial weight among producer groups reflected not only genetic differences in frame size and muscle thickness, but also differences in condition stemming from the effects of prefinishing nutritional management. Steers that were larger framed, more thickly muscled, and(or) heavier conditioned weighed more at processing than did steers that were smaller framed, more thinly muscled, and(or) thinner in condition. Differences in body condition generally contrasted producer groups that had been preconditioned in a drylot (producer groups 2 and 3) with those that entered the feedlot directly from pasture (producer groups 1, 4, 5, and 6).

Table 2. Breed group means for growth and carcass traits adjusted to a constant slaughter weight<sup>a</sup>

Trait	100H (n = 77)	75H:25B (n = 80)	50H:50B (n = 79)	Residual SD <sup>b</sup>
Average daily gain, kg	1.83 <sup>e</sup>	1.64 <sup>f</sup>	1.53 <sup>g</sup>	.25
Hot carcass weight, kg	317.2 <sup>f</sup>	319.4 <sup>f</sup>	326.6 <sup>e</sup>	10.88
Adjusted fat thickness, cm	1.15 <sup>e</sup>	1.13 <sup>e</sup>	1.05 <sup>e</sup>	.34
Ribeye area, cm <sup>2</sup>	76 <sup>f</sup>	80 <sup>e</sup>	80 <sup>e</sup>	6.30
% KPH fat <sup>c</sup>	2.16 <sup>e</sup>	2.20 <sup>e</sup>	2.34 <sup>e</sup>	.46
Yield grade	3.11 <sup>e</sup>	2.91 <sup>e</sup>	2.92 <sup>e</sup>	.53
Maturity <sup>d</sup>	45.8 <sup>f</sup>	54.5 <sup>e</sup>	55.9 <sup>e</sup>	10.61
Marbling score	SI <sup>91</sup> e	SI <sup>47</sup> f	SI <sup>45</sup> f	48.44

<sup>a</sup>Analysis of covariance techniques were used to adjust each trait to a constant slaughter weight of 537.3 kg.

<sup>b</sup>Standard error of least squares means may be calculated as  $1/\sqrt{n} \times$  residual SD for a trait, where n = number of steers in that particular subclass.

<sup>c</sup>Estimated percentage of kidney, pelvic and heart fat.

<sup>d</sup>A maturity = 0 to 99, B maturity = 100 to 199.

<sup>e,f,g</sup>Within a row, means with a common superscript letter do not differ ( $P > .05$ ).

Differences in initial weight among breed groups stemmed primarily from differences in body condition (Table 1). Breed-group differences in frame size and muscularity, though statistically significant, were of little practical importance; in general, steers in all three breed groups were scored as "medium-framed" and "average" in muscularity.

**Weight-Constant Comparison of Breed Groups.** Breed group means for growth and carcass traits compared at a constant finished weight of 537 kg (the overall mean live weight at slaughter) are presented in Table 2. Because steers in the three breed groups were very similar in frame size and muscularity, all three groups had similar ( $P > .05$ ) mean values for external fat thickness and yield grade when compared at the same live slaughter weight. This suggests that steers in the three groups had attained similar stages of compositional development (i.e., were at similar stages of developmental maturity) at 537 kg. Therefore, data in Table 2 provided the most valid comparisons of breed differences in growth and carcass traits. Despite their similarities in live weight and external fat thickness, the three breed groups differed ( $P < .05$ ) in growth rate (100H > 75H:25B > 50H:50B), hot carcass weight (which in this analysis is synonymous with dressing percentage: 50H:50B > 75H:25B = 100H), longissimus muscle area (50H:50B = 75H:25B > 100H), carcass maturity (100H < 75H:25B = 50H:50B), and marbling score (100H > 75H:25B = 50H:50B).

In the present study, average daily gain decreased as the proportion of Brahman breeding increased from 0% to 25% to 50% (Table 2). Peacock et al. (1982) conducted a study designed to determine additive breed and heterosis effects on feedlot performance and carcass traits using straightbred and crossbred steers of Brahman, Angus, and Charolais breeding. They found that the direct additive Brahman breed effects were negative for average daily gain. Franke (1995), summarizing results of several research trials conducted between 1959 and 1994 in a variety of

production environments, also noted a tendency for growth rate to decline as the percentage of Brahman breeding increased, but only when the percentage of Brahman breeding exceeded 50%.

Breed differences in dressing percentage (100H = 61.5, 25H:75B = 61.9, 50H:50B = 63.3) observed in the present study (Table 2) were consistent with results of previous research. Several studies (Carroll et al., 1955; Damon et al., 1960; Moran, 1970; Koch et al., 1982) have documented greater dressing percentages for Brahman crossbreds than for British breeds of cattle.

Some evidence suggests that Brahman crossbred cattle have smaller longissimus muscle areas than do British breeds of cattle (Lockett et al., 1975; Peacock et al., 1982; Huffmann et al., 1990). Other studies have shown no difference in longissimus muscle area between Brahman crossbreds and British breeds (Koch et al., 1982; Crouse et al., 1989). In the present study Brahman crossbred (both quarter-blood and half-blood) steers had larger longissimus muscle areas than did straightbred Hereford steers (Table 2).

Marbling scores for Brahman crossbreds consistently have been shown to rank relatively low in comparison with marbling scores for other cattle breeds (Damon et al., 1960; Lockett et al., 1975; Young et al., 1978; Peacock et al., 1982; Koch et al., 1982; DeRouen et al., 1992). Moreover, Crouse et al. (1989) and Huffman et al. (1990) reported data suggesting that an increase in the proportion of Brahman breeding was associated with decreased marbling. In our study, 75H:25B and 50H:50B steers had similar marbling scores, and both groups had lower marbling scores than did 100H steers (Table 2). Differences in carcass maturity observed among breed groups in the present study, though statistically significant, were of questionable practical importance. Means for carcass maturity of all three breed groups were in the middle third of the A-maturity classification.

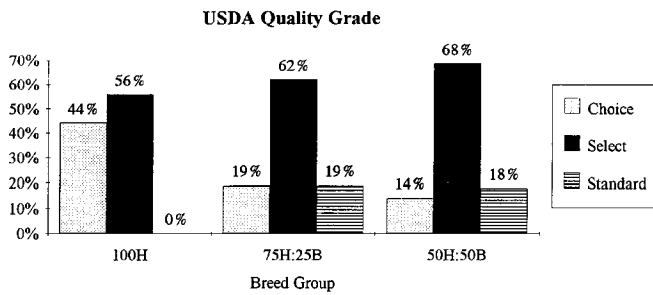


Figure 1. Quality grade frequency by breed.

The USDA quality grade distribution (computed across all days on feed endpoints) for each breed group represented in the present study is shown in Figure 1. The percentage of Select grade carcasses produced by steers of the three breed groups did not differ ( $P > .05$ ). However, as a result of their higher marbling scores, 100H steers produced a larger ( $P < .05$ ) percentage of Choice grade carcasses and a smaller ( $P < .05$ ) percentage of Standard grade carcasses, as compared with both groups of Brahman crossbred steers (Figure 1). Quality grade distributions for the two Brahman crossbred groups did not differ ( $P > .05$ ). A noteworthy feature of the data presented in Figure 1 is that none of the carcasses produced by the straightbred Hereford steers graded Standard. Other studies conducted at Colorado State University to characterize carcass traits of straightbred Hereford steers (Huffhines, 1992; Ledall, 1993) consistently have shown that straightbred Hereford cattle produce a very low percentage of Standard carcasses.

**Effects of Breed Group, Time on Feed, and Postmortem Aging on Palatability Traits.** Mean squares summarizing results of the repeated measures analysis for sensory panel ratings and shear force are provided in Table 3. Strip loin samples, removed from each carcass, were aged for two different time periods (6 and 18 d after death) to simulate two different beef distribution scenarios. The 6-d aging period was chosen to represent the segment of the boxed-beef trade that moves rapidly through the distribution system and reaches consumers in a "shorter-than-average" time period, whereas the 18-d aging period was chosen to represent the average postmortem aging time for retail beef as determined by the National Beef Tenderness Survey (Morgan et al., 1991).

Length of the aging period had a highly significant ( $P < .01$ ) effect on shear force and on sensory panel ratings for tenderness (Table 3). On average, extending the postmortem aging period from 6 to 18 d improved shear force values by 20% and panel tenderness ratings by 14.3%. The between breed and aging time interaction was not significant for any of the traits tested, suggesting that palatability attributes of beef produced by steers of the three breed

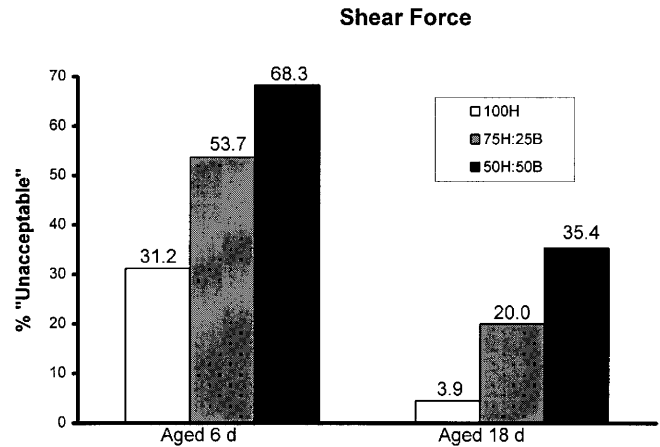


Figure 2. Incidence (%) of steaks with "unacceptable" values for shear force. Shear force values  $\geq 3.9$  kg were considered unacceptable (Morgan et al., 1991).

groups responded similarly to aging from 6 to 18 d. In contrast to these findings, Johnson et al. (1990) reported that beef produced by cattle with 50% or 75% Brahman breeding showed less improvement in tenderness during postmortem aging (1-, 5-, and 10-d aging periods) than did beef produced by cattle with 0% or 25% Brahman breeding.

In the present study, breed group had a highly significant ( $P < .01$ ) effect on shear force and on sensory panel ratings for tenderness and juiciness (Table 3). Generally, as the percentage of Brahman breeding increased (Table 4), shear force values increased ( $P < .05$ ), whereas ratings for tenderness and juiciness decreased ( $P < .05$ ).

Days on feed had a small yet significant effect on shear force and panel tenderness ratings. However, differences in palatability attributes associated with days-on-feed effects were not consistent among breed groups or among aging periods, as indicated by significant breed  $\times$  days-on-feed and days-on-feed  $\times$  aging effects in Table 3. Regardless of breed type or length of the postmortem aging period, the level of tenderness improvement associated with increased time-on-feed beyond 84 d was small in magnitude and of questionable practical importance. Moreover, time-on-feed did not impact juiciness or beef flavor intensity (Table 3).

To compare the three breed groups with respect to their conformance to desired specifications for beef tenderness, an "acceptable" threshold value of  $< 3.9$  kg was chosen for shear force (Morgan et al., 1991), recognizing that absolute shear values may differ between research locations. Data showing the percentage of steers in each breed group failing to meet this criterion after 6 or 18 d of postmortem aging are presented in Figure 2.

After 6 d of postmortem aging, loin steaks from approximately half (51.3%) of all steers failed to meet the acceptable threshold for shear force. Extending the

Table 3. Repeated measures analyses for beef palatability traits and shear force values

Source of variation	df	Juiciness	Tenderness	Flavor intensity	Shear force
Between-subject effects					
Breed	2	3.18**	21.84**	.11	34.46**
Producer (breed) <sup>a</sup>	4	.24	2.18**	.09	4.47**
Days on feed	3	.35	2.52**	.11	3.93*
Linear	1	.71*	5.46**	.22	3.94
Quadratic	1	.15	1.19	.04	.16
Cubic	1	.20	.96	.08	7.66**
Breed × days on feed	6	.60**	1.22*	.04	1.61
Error	220	.18	.52	.08	1.05
Within-subject effects					
Aging period	1	.33	48.08**	.03	76.46**
Breed × aging	2	.04	.14	.03	.34
Producer (breed) × aging	4	.02	.11	.01	.47
Days on feed × aging	3	.14	.97*	.16	1.55**
Breed × days on feed × aging	6	.07	.11	.02	.57*
Error	220	.15	.18	.07	.23

<sup>a</sup>Effect of producer nested within breed.

\*Denotes significance ( $P < .05$ ).

\*\*Denotes significance ( $P < .01$ ).

aging period to 18 d reduced the overall rate of nonconformance for shear force to 19.9%. These results underscore the importance of an adequate postmortem aging period for assuring acceptable beef tenderness.

In general, the incidence of steaks failing to conform to the acceptable shear force specification increased as the percentage of Brahman breeding increased (Figure 2). Nonconformance rates were unacceptably high for all three breed groups when loin samples were aged for only 6 d. After 18 d of aging, only 3.9% of steaks from 100H steers had “unacceptable” shear values. However, both Brahman crossbred groups still had a relatively high incidence of steaks

with “unacceptable” shear force values even after aging for 18 d. When results presented in Figure 2 are interpreted, it should be noted that steers in both of the crossbred groups had substantially lower quality grades than did the 100H steers (Figure 1). However, previous research has shown that tenderness differences between *Bos indicus* and *Bos taurus* cattle are associated with differences in postmortem muscle proteolysis, not with differences in marbling (Whipple et al., 1990; Wheeler et al., 1990; Shackelford et al., 1991).

*Application of Results to the Certified Hereford Beef Program.* A substantial number of southern U.S. cattle producers currently use purebred Hereford bulls that

Table 4. Least squares means for palatability traits and shear force values of steaks aged 6 and 18 days

Source	n	Juiciness	Tenderness	Flavor intensity	Shear force, kg
6-day aging					
100H	77	5.17 <sup>a</sup>	4.92 <sup>a</sup>	5.04	3.64 <sup>a</sup>
75H:25B	80	5.08 <sup>a</sup>	4.62 <sup>b</sup>	5.05	4.08 <sup>b</sup>
50H:50B	79	4.90 <sup>b</sup>	4.12 <sup>c</sup>	4.98	4.57 <sup>c</sup>
Residual SD <sup>d</sup>		.41	.66	.28	.89
18-day aging					
100H	77	5.14 <sup>a</sup>	5.52 <sup>a</sup>	5.03	2.91 <sup>a</sup>
75H:25B	80	4.99 <sup>b</sup>	5.25 <sup>b</sup>	5.00	3.27 <sup>b</sup>
50H:50B	79	4.84 <sup>c</sup>	4.83 <sup>c</sup>	4.99	3.75 <sup>c</sup>
Residual SD <sup>d</sup>		.41	.53	.26	.70

<sup>a,b,c</sup>Means in the same row with a common superscript letter or no superscript letter do not differ ( $P > .05$ ).

<sup>d</sup>Standard error of least squares means may be calculated as  $1/\sqrt{n} \times$  residual SD for a trait, where n = number of steaks in that particular subclass.

Table 5. Effects of breed constraints and Certified Hereford Beef (CHB) specifications<sup>a</sup> on shear force of loin steaks aged for 18 days

Breed constraint	CHB specifications applied	n	Shear force, kg		Frequency of shear values $\geq 3.9$ kg, %
			Mean	SD	
$\leq 50\%$ Brahman	No	236	3.31 <sup>b</sup>	.805	19.9 <sup>b</sup>
$\leq 50\%$ Brahman	Yes	118	3.19 <sup>bc</sup>	.838	15.3 <sup>bc</sup>
$\leq 25\%$ Brahman	No	157	3.09 <sup>cd</sup>	.662	12.1 <sup>c</sup>
$\leq 25\%$ Brahman	Yes	85	2.94 <sup>de</sup>	.634	8.2 <sup>cd</sup>
No Brahman	No	77	2.91 <sup>de</sup>	.585	3.9 <sup>d</sup>
No Brahman	Yes	54	2.88 <sup>e</sup>	.584	3.7 <sup>d</sup>

<sup>a</sup>Minimum marbling score of Slight<sup>50</sup>, hot carcass weight of 272.2 to 385.6 kg, and USDA yield grade of 3.5 or better.

<sup>b,c,d,e</sup>Values in the same column sharing a common superscript letter do not differ ( $P > .05$ ).

are mated to Brahman and Brahman crossbred cows, producing a supply of feeder cattle that are known to be at least 50% Hereford and contain up to 50% Brahman breeding. An objective of this study was to determine whether Hereford  $\times$  Brahman crossbred steers with 25% or 50% Brahman breeding could be included in the CHB Program without adverse effects on product tenderness. Data presented in Table 5 outline the approach taken to address this objective.

The first constraint applied was breed, and three different breed constraints were tested: 1) up to 50% Brahman breeding (which included all cattle in the experimental sample); 2) up to 25% Brahman breeding (which included all 75H:25B steers and all 100H steers); 3) no Brahman breeding (which included only 100H steers). In addition to these breed constraints, current CHB specifications were tested. Carcass specifications for CHB require 1) a minimum marbling score of Slight<sup>50</sup>, 2) a hot carcass weight of 272.2 to 385.6 kg, and 3) a USDA yield grade of 3.5 or better.

Results reported in Table 5 suggest that allowing steers with 50% Brahman breeding into the CHB Program would have an adverse effect on product tenderness, even if carcasses met current CHB specifications. Steaks produced by steers with up to 50% Brahman breeding had higher, more variable shear force values and a greater incidence of shear values  $>3.9$  kg compared with steaks from steers containing no Brahman breeding. However, steers with up to 25% Brahman breeding that met CHB carcass specifications produced steaks with shear force values comparable to those for steaks from steers with no Brahman breeding, suggesting that quarter-blood Brahman steers could be included in the CHB Program without significantly reducing product tenderness.

It is noteworthy that use of the CHB Program carcass specifications seemed to improve tenderness only slightly within each breed grouping. This indicates that the use of a minimum marbling specification in this population of steers had little effect on tenderness of loin steaks aged for 18 d.

## Implications

Currently, cattle showing phenotypic evidence of Brahman breeding are excluded from the Certified Hereford Beef Program due to concerns about product tenderness. Results of the present study suggest that including Hereford crossbred steers with 50% Brahman breeding would adversely affect the tenderness of Certified Hereford Beef. However, Hereford crossbreds with 25% Brahman breeding could be allowed in the Certified Hereford Beef Program without significantly increasing the risk of decreased product tenderness.

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