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Abstract

In semitropical climates in the United States, Bos indicus breeds of cattle, primarily the Brahman breed, are utilized in crossbreeding programs with Bos taurus cattle to improve productivity by increasing disease and insect resistance, heat tolerance, heterosis, and additive genetic variation. About 25% of the U.S. beef population contains some Bos indicus breeding. Numerous published reports show that tenderness of ribeye and strip loin steaks and marbling are significantly reduced in Bos indicus straightbred or crossbred cattle compared to most Bos taurus breeds. One very large study reported that heritability of tenderness and marbling is around 0.4, making it a positive trait to try to improve through selection. Only one published report has compared tenderness differences between Bos indicus and Bos taurus cattle for more than the ribeye and strip loin (longissimus muscle) and that study showed that other muscles were less tender for Bos indicus cattle. The objectives of our study were: (1) to compare carcass traits between Hereford x Angus crossbred cattle with those containing at least 50% Brahman and Sahiwal inheritance, and (2) to validate Warner-Bratzler shear force of steaks and roasts and proximate composition of 10 different muscles from these cattle.

Keywords

Kansas Agricultural Experiment Station contribution; no. 11-171-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1047; Cattlemen's Day, 2011; Beef; Tenderness; Bos indicus; Bos taurus; Warner-Bratzler shear machine; Marbling

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Tenderness and Intramuscular Lipid of Most Major Muscles from *Bos Indicus* Cattle are Less than *Bos Taurus* Cattle

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Introduction

In semitropical climates in the United States, *Bos indicus* breeds of cattle, primarily the Brahman breed, are utilized in crossbreeding programs with *Bos taurus* cattle to improve productivity by increasing disease and insect resistance, heat tolerance, heterosis, and additive genetic variation. About 25% of the U.S. beef population contains some *Bos indicus* breeding. Numerous published reports show that tenderness of ribeye and strip loin steaks and marbling are significantly reduced in *Bos indicus* straightbred or crossbred cattle compared to most *Bos taurus* breeds. One very large study reported that heritability of tenderness and marbling is around 0.4, making it a positive trait to try to improve through selection. Only one published report has compared tenderness differences between *Bos indicus* and *Bos taurus* cattle for more than the ribeye and strip loin (longissimus muscle) and that study showed that other muscles were less tender for *Bos indicus* cattle. The objectives of our study were: (1) to compare carcass traits between Hereford x Angus crossbred cattle with those containing at least 50% Brahman and Sahiwal inheritance, and (2) to validate Warner-Bratzler shear force of steaks and roasts and proximate composition of 10 different muscles from these cattle.

Experimental Procedures

Twenty *Bos taurus* (Hereford x Angus) and 20 *Bos indicus* (Brahman or Sahiwal sires mated to Hereford and Angus cows), from Phase 5 of Cycle III of the Germ Plasm Evaluation Project conducted at the Roman L. Hruska U.S. Meat Animal Research Center (Clay Center, NE) were used. Calves were weaned at approximately 200 days of age, preconditioned 30 days, and then fed a corn and corn silage diet until harvest after 169 days on feed. Carcasses were electrically stimulated and chilled for 24 hours postmortem, ribbed at the 12th rib, and evaluated for carcass traits by USDA graders. Right sides were fabricated to obtain the following muscles: *supraspinatus* (SS), *infraspinatus* (IF), and *triceps brachii* (TB) from the chuck; *deep pectoral* (DP) from the brisket; *longissimus lumborum* (LL), *psoas major* (PM), and *gluteus medius* (GM) from the loin; and *biceps femoris* (BF), *semitendinosus* (ST), and *semimembranosus* (SM) from the round. One steak was cut from each muscle, trimmed of visible connective tissue and external fat, and used for fat, moisture, and protein analysis. Remaining portions of the muscles were vacuum packaged, aged at 2°F until 10 days postmortem, then blast frozen at -40°F for 8 hours. One 1-in. steak and one roast were cut from each frozen muscle using a power band saw. The size for roasts was dependent on the muscle size. The SS, TB, DP, GM, and BF were cut into 2-in.-thick roasts; the other muscles were cut into 3-in.-thick roasts.

Steaks and roasts were thawed at room temperature, held overnight in a cooler, cooked in a 325°F Blodgett oven to an internal temperature of 150°F, and cooled for 2 hours at room temperature. Then 0.5-in.-diameter cores were removed and sheared using a

Warner-Bratzler shear machine. Data were analyzed statistically using SAS GLM procedures with a probability level of P<0.05 for mean separations.

Results and Discussion

Carcass traits are shown in Table 1. *Bos taurus* carcasses were heavier, had more fat cover, and had larger ribeye areas than the *Bos indicus* carcasses (P≤0.05). In addition, *Bos taurus* carcasses had higher marbling scores (P=0.08). Yield grade tended to be higher for *Bos taurus* but it was not statistically significant. Intramuscular fat percentage was higher (P<0.05) in all *Bos taurus* muscles compared to *Bos indicus* muscles (Table 2). The IF muscle had the highest fat percentage; SM had the least intramuscular fat. Differences in intramuscular fat percentages between breeds were noticeably greater for the LM and BF muscles than for the other muscles.

The percent cooking loss for each muscle was pooled for the breed types and is shown in Table 3. For all muscles except TB, roasts took less time per oz to reach the final end point temperature than steaks (data not shown). Cooking losses were less (P<0.05) for TB, LL, and SM steaks than for roasts, and greater (P<0.05) for PM and GM roasts than steaks. Cooking loss in steaks and roasts was similar for SS, IF, DP, and BF muscles. The relative surface area exposed to heat was greater for steaks, resulting in more intense evaporation that required more time per oz of raw weight to reach the final internal temperature.

Figures 1 through 9 show Warner-Bratzler shear force values for the 10 muscles. In the forequarter, no breed or cut size main effect differences occurred in Warner-Bratzler shear force for SS muscles (Figure 1) but a breed × cut size interaction (P<0.001) arose where roasts from *Bos taurus* had higher (P<0.05) Warner-Bratzler shear force values than steaks, whereas no differences occurred among steaks and roasts for *Bos indicus*. No breed differences were found for IF (Figure 2), but roasts for both breed types were more tender than steaks. For the TB muscle, both steaks and roasts from *Bos taurus* were more tender (P<0.05) than those from *Bos indicus* (Figure 3). Figure 4 shows that steak tenderness of DP was not different between breeds, but *Bos indicus* roasts were less tender (P<0.05) than roasts from *Bos taurus*. Surprisingly, the DP was more tender when cooked as steaks than as roasts (P<0.05).

Figure 5 shows that *Bos indicus* LL roasts and steaks had higher (P<0.05) Warner-Bratzler shear force values than *Bos taurus* and steaks for both breeds had greater (P<0.05) Warner-Bratzler shear force values than roasts. For the GM muscle, *Bos taurus* was more tender (P<0.05) than *Bos indicus* when cooked as steaks and roasts (Figure 6). The BF muscle from *Bos indicus* was less tender (P<0.05) than *Bos taurus* when cooked as steaks but not when cooked as roasts (Figure 7). When ST muscles were cooked as steaks, no breed differences were observed, but *Bos indicus* ST roasts were less tender (P<0.05) than *Bos taurus* roasts (Figure 8). In addition, ST roasts had lower Warner-Bratzler shear force values than steaks. For SM steaks and roasts, *Bos indicus* muscles were tougher (P<0.01) than *Bos taurus* muscles (Figure 9). In addition, SM muscles were less tender (P<0.05) when cooked as roasts than when cooked as steaks.

Implications

When handled to have a similar age, background, management, and days on feed, *Bos taurus* carcasses were expected to be heavier, have more fat cover, have larger ribeye areas, higher marbling scores, and greater intramuscular fat percentages for all 10 muscles than *Bos indicus* carcasses. Furthermore, muscles cooked as roasts were expected to cook faster per unit weight than steaks. From the forequarter, tenderness of the SP and IF muscles were not expected to differ due to breed or cut size. However, *Bos indicus* TB muscles were expected to be less tender than those from *Bos taurus*. *Bos taurus* LL, GM, and SM muscles cooked as steaks were expected to be more tender than those from *Bos indicus*, and *Bos taurus* LL, GM, ST and SM muscles cooked as roasts were expected to be more tender than those from *Bos indicus*. Overall, 7 of the 10 muscles evaluated were more tender from *Bos taurus* when cooked as steaks, roasts, or both cut sizes.

Table 1. Carcass traits for *Bos indicus* and *Bos taurus* heifers

	Mean		P-value
Traits	*Bos indicus*	*Bos taurus*	Breed
Hot carcass weight, lb	512.79	572.32	0.05
Maturity[a]	53	55	0.47
Marbling[b]	386	434	0.08
Fat Thickness, in.	0.35	0.47	0.01
Adjusted fat, in.	0.31	0.43	0.02
Ribye area, in.^{2}	10.12	11.11	0.05
Kidney, pelvic, and heart fat, %	2.5	2.8	0.13
Yield grade	2.57	2.86	0.2

[a] All carcasses were A maturity; number refers to percentage within A maturity.
[b] 386 = Slight^{86}, 434 = Small^{34}

Table 2. Mean percentages of intramuscular fat by muscle and breed

	Intramuscular fat, %	
Muscle	*Bos indicus*	*Bos taurus*
Supraspinatus	2.13^{g}	2.82^{g}
Infraspinatus	6.17^{a}	7.80^{a}
Triceps brachii	3.25^{f}	3.48^{f}
Deep pectoral	3.22^{ef}	4.13^{ef}
Longissimus lumborum	3.79^{cd}	5.75^{cd}
Psoas major	5.33^{b}	6.46^{b}
Gluteus medius	3.94^{de}	4.55^{de}
Biceps femoris	3.61^{cd}	5.67^{cd}
Semitendinosus	4.49^{c}	5.76^{c}
Semimembranosus	1.33^{h}	1.68^{h}

^{abcdefgh} Means within a column lacking a common superscript letter differ ($P<0.05$). Fat percentages in all muscles were higher for the *Bos taurus* cattle ($P=0.001$).

Table 3. Least squares means for cooking loss, %

	Roast	Steak
Supraspinatus	31.59[a]	30.55[a]
Infraspinatus	28.99[a]	28.57[a]
Triceps brachii	28.04[a]	25.42[b]
Deep pectoral	25.64[a]	24.62[a]
Longissimus lumborum	28.83[a]	23.56[b]
Psoas major	28.64[a]	30.03[b]
Gluteus medius	27.69[a]	29.89[b]
Biceps femoris	28.47[a]	28.06[a]
Semitendinosus	N/A	N/A
Semimembranosus	34.80[a]	29.49[b]

[ab] Means comparing cooking losses within each muscle lacking common superscript differ (P<0.05).

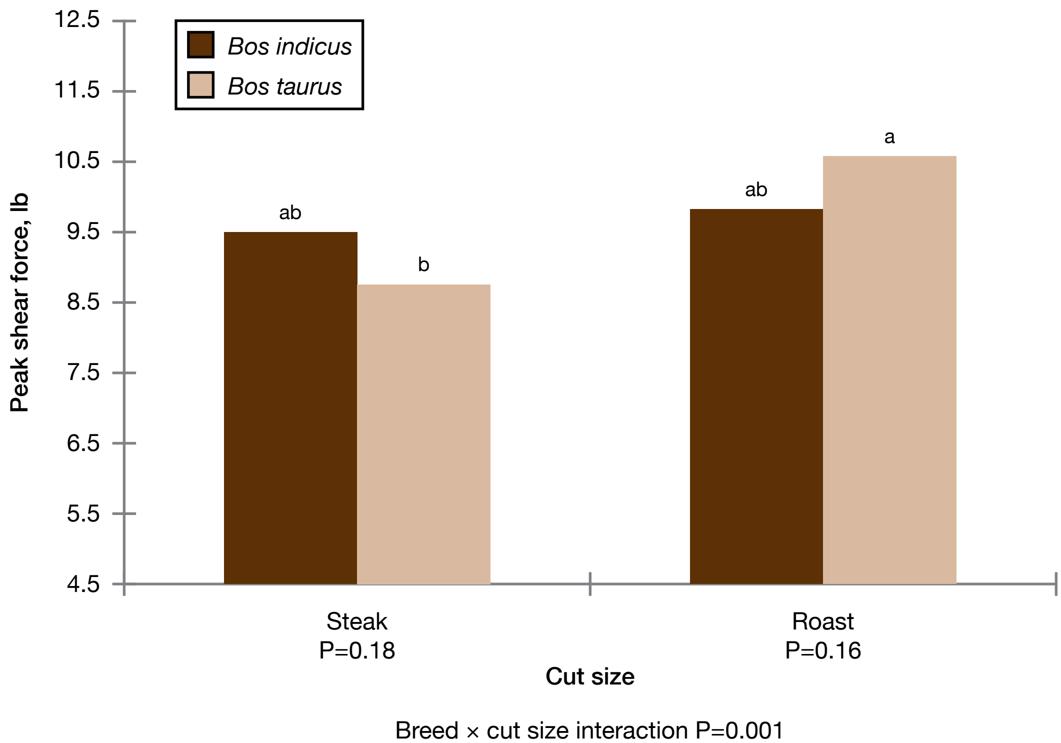

Figure 1. Peak force by breed and cut size in *Supraspinatus* muscles.

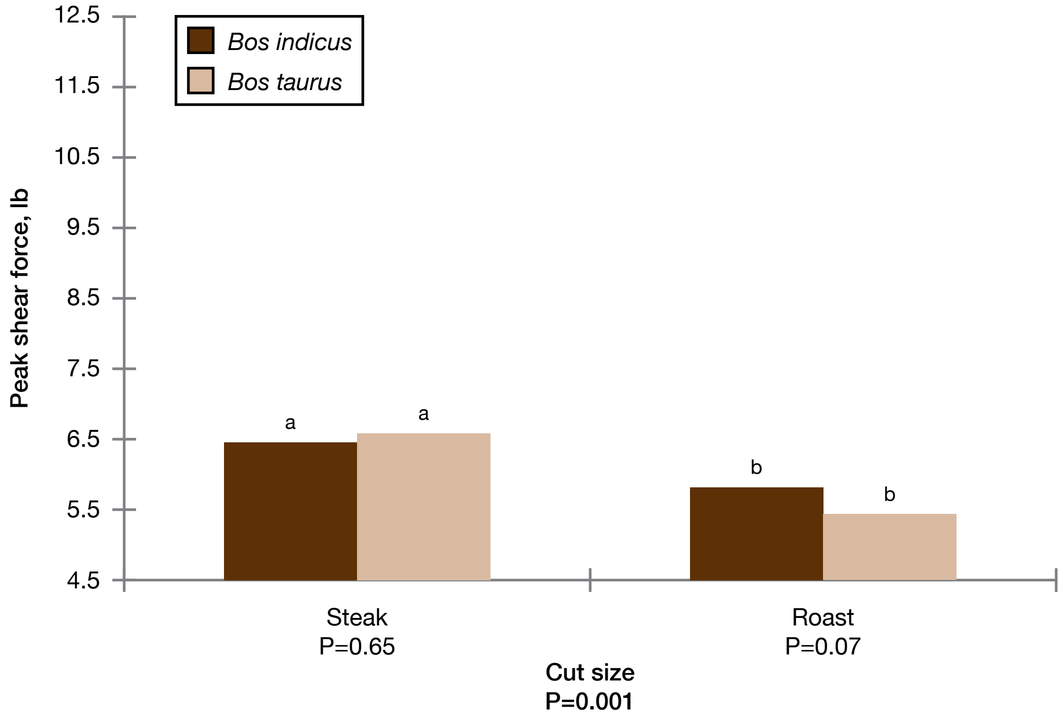

Figure 2. Peak force by breed and cut size in *Infraspinatus* muscles.

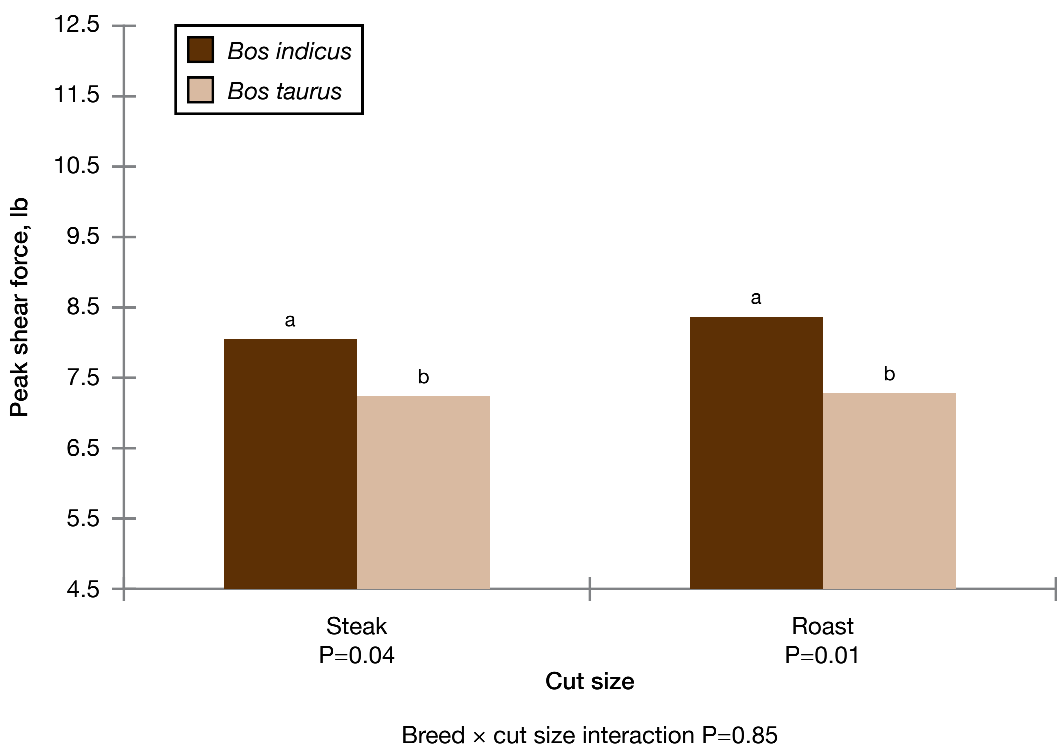

Figure 3. Peak force by breed and cut size in *Triceps brachii* muscles.

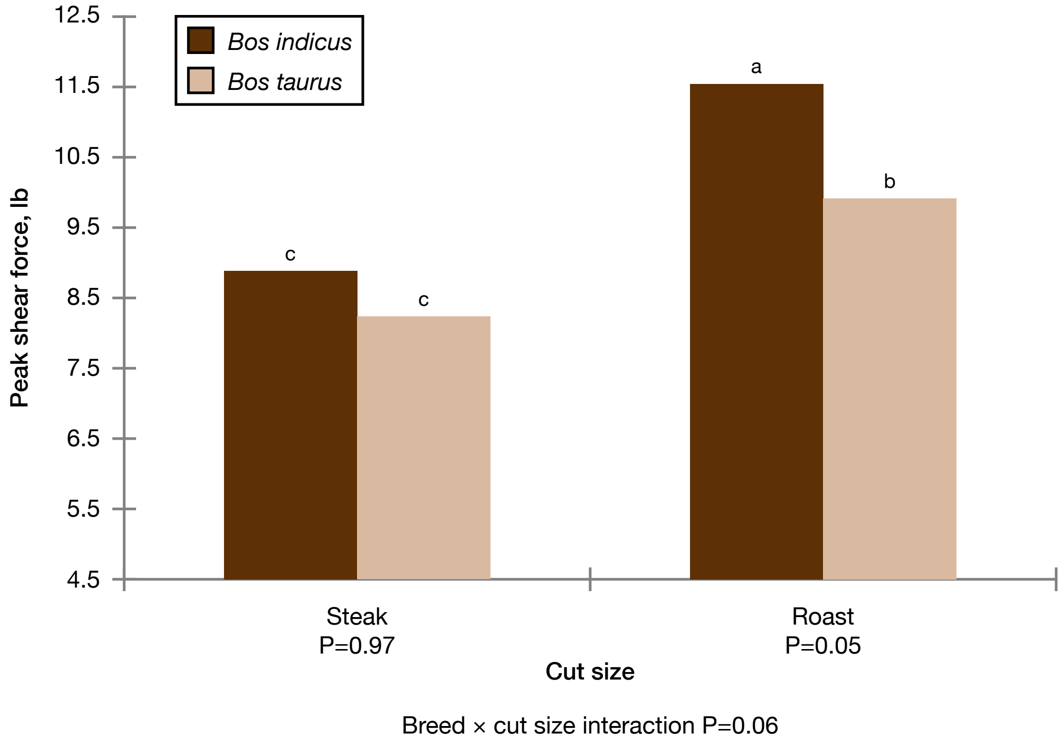

Figure 4. Peak force by breed and cut size in *Deep pectoral* muscles.

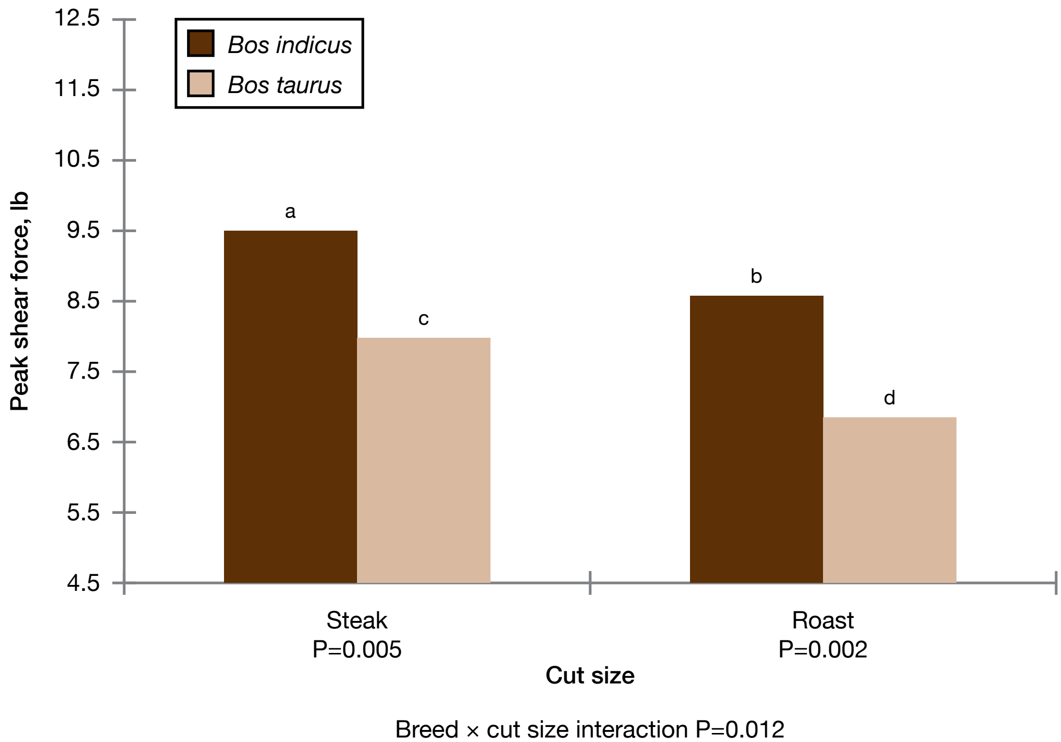

Figure 5. Peak force by breed and cut size in *Longissimus lumborum* muscles.

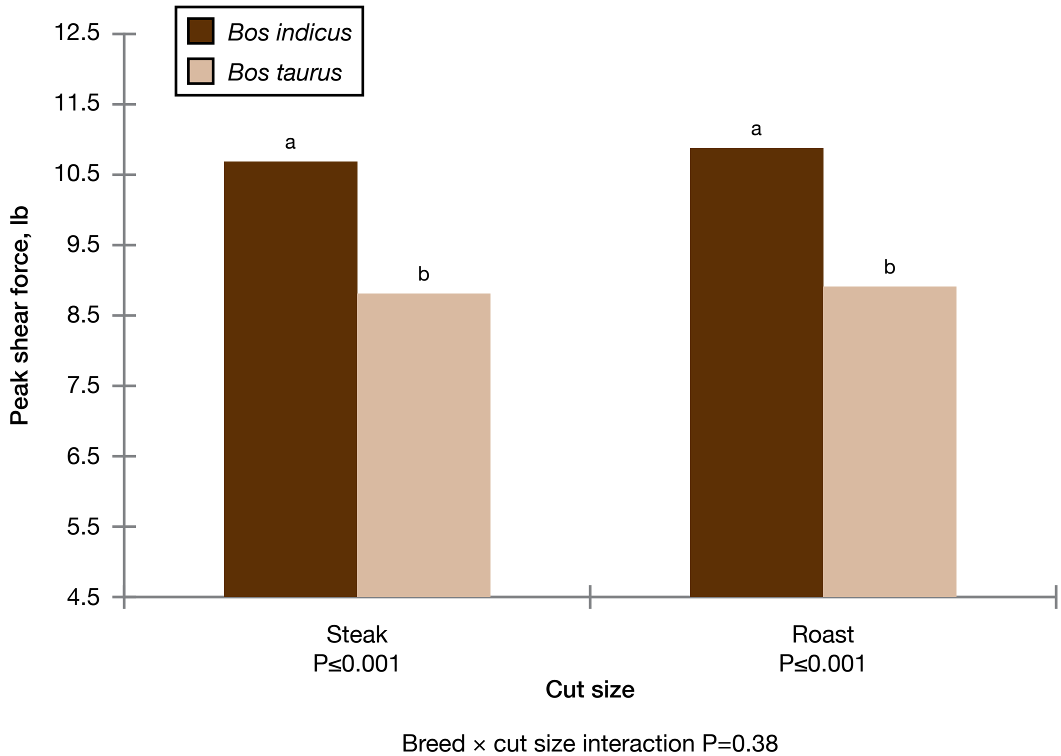

Figure 6. Peak force by breed and cut size in *Gluteus medius* muscles.

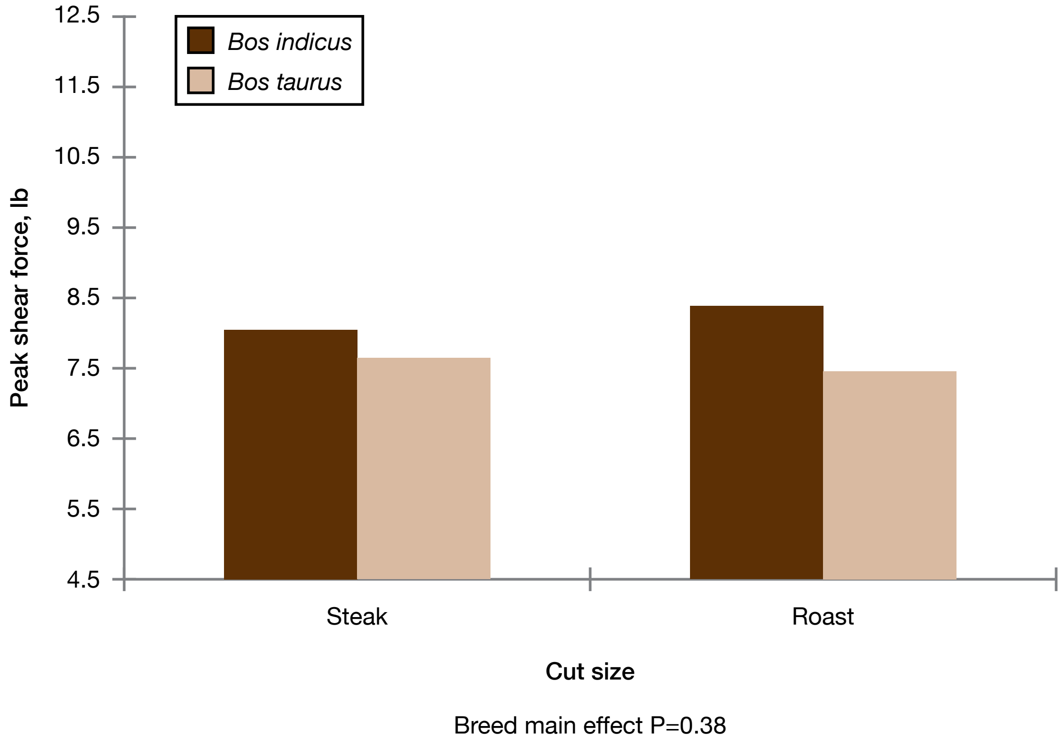

Figure 7. Peak force by breed and cut size in *Psoas major* muscles.

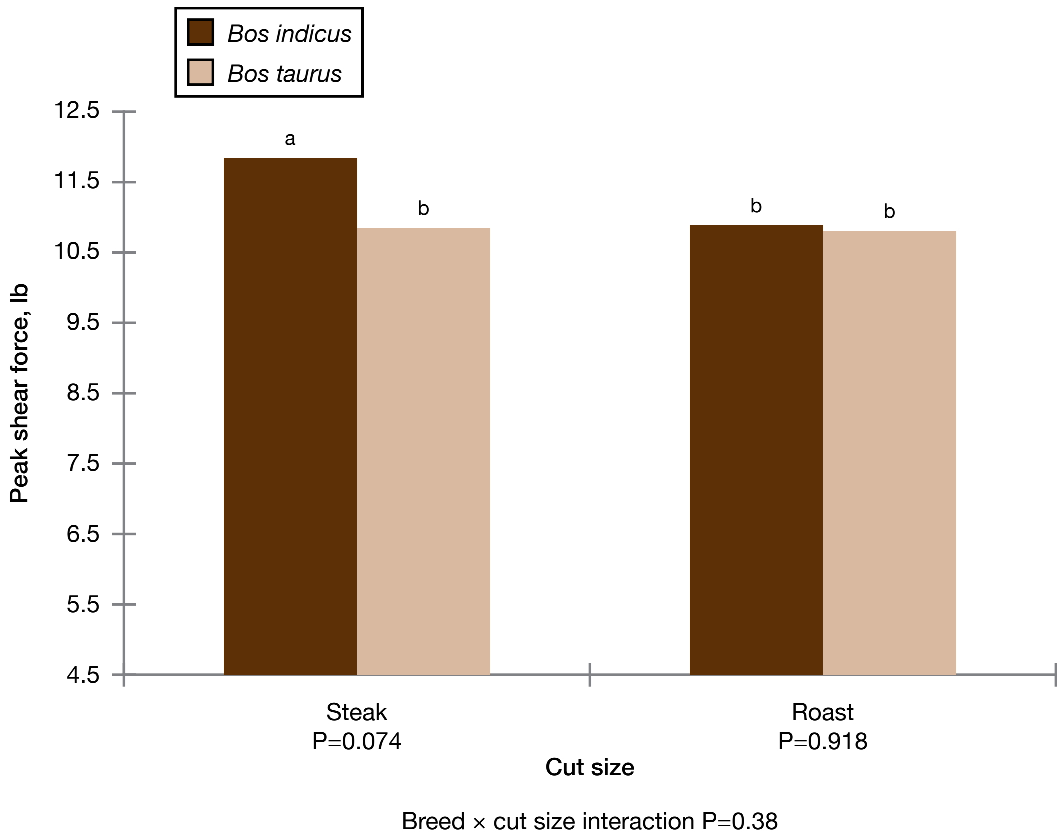

Figure 8. Peak force by breed and cut size in *Biceps femoris* muscles.

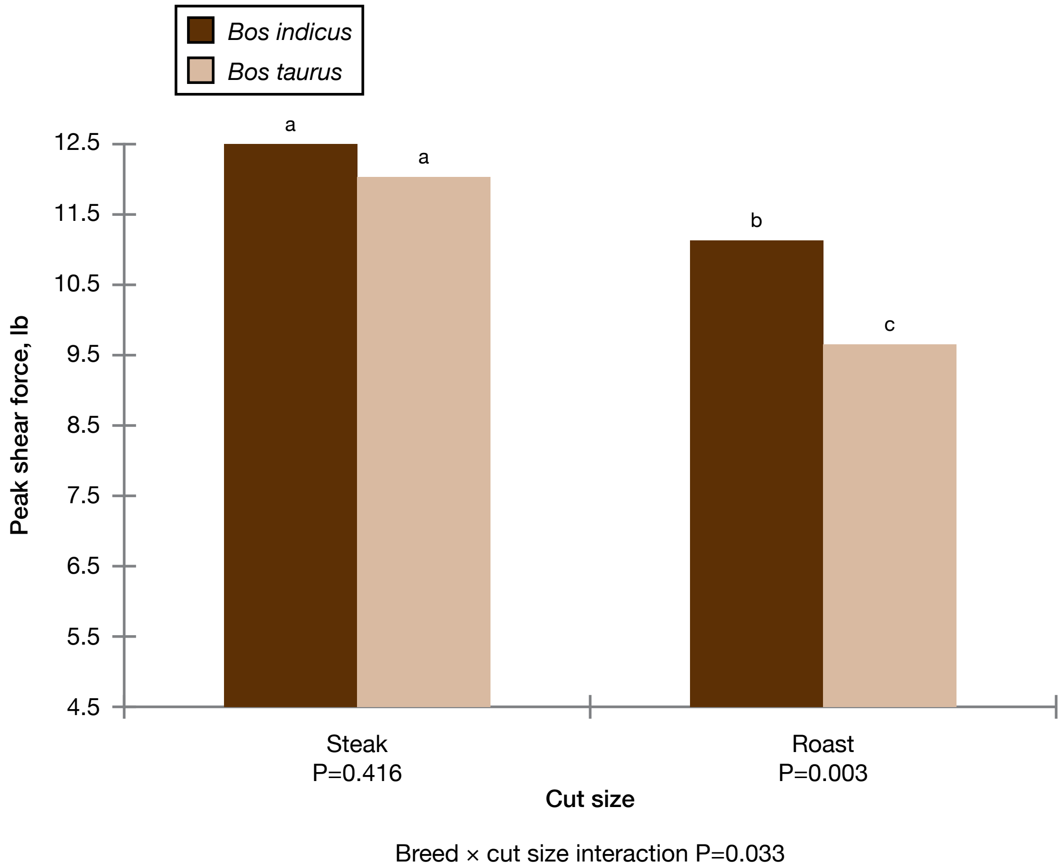

Figure 9. Peak force by breed and cut size in *Semitendinosus* muscles.

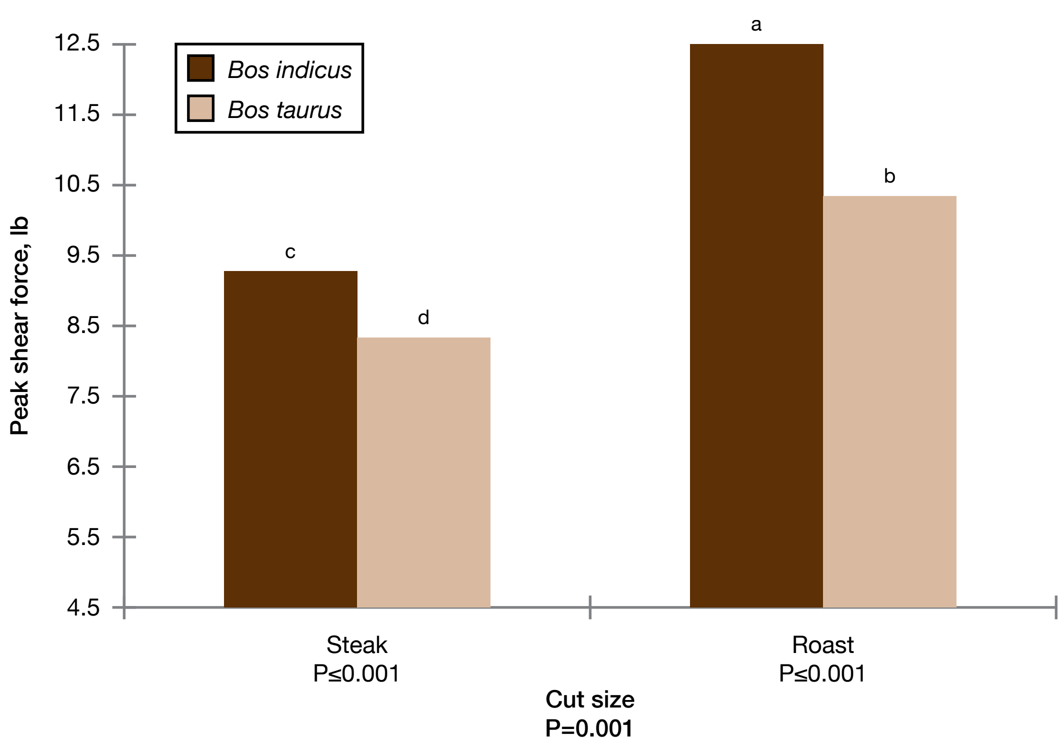

Figure 10. Peak force by breed and cut size in *Semimembranosus* muscles.