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Brahman Genetics Negatively Impact Protein Degradation and Tenderness of *Longissimus Lumborum* Steaks, but do Not Influence Collagen Cross-Linking

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Introduction

Beef tenderness is an important factor contributing to consumer eating satisfaction of beef products. Tenderness is dependent on several factors including: breed-type, postmortem age time, myofibrillar muscle protein degradation, and collagen content. During the past 30 years, numerous studies have indicated steaks from cattle with a greater percentage of Brahman genetics are tougher than steaks from *Bos taurus* cattle. The cause of tougher steaks is commonly attributed to Brahman cattle having a greater calpastatin activity which inhibits calpains, the enzymes responsible for myofibrillar protein degradation during the postmortem aging process. Some researchers have reported calpastatin activity was poorly correlated to tenderness of steaks from Brahman cattle. Others have reported sensory panelists indicated steaks from cattle with increasing percentages of Brahman genetics have an increase in the amount of connective tissue or collagen. Additionally, researchers have reported an increase in expression of genes that play a role in cross-linking of collagen which decreases collagen solubility. Due to these findings, we hypothesized steaks from cattle with greater Brahman genetics have more collagen cross-links and therefore a less soluble collagen fraction. The objective of this study was to evaluate the effect of Brahman genetics on protein degradation, collagen cross-linking, and meat tenderness of strip loin steaks.

Key words: Brahman, collagen, tenderness

Experimental Procedures

Steers (n = 131) from the University of Florida Multi-breed Herd born in 2012 and 2013 were classified into four breed categories. The four breed categories were Angus in which steers had 26/32nd or greater of Angus genetics (100% Angus/0% Brahman), Brangus in which steers had 20/32nd Angus genetics (62.5% Angus/32.5% Brahman), Half-Blood in which steers had 14/32 to 18/32nd Angus genetics (50% Angus/50% Brahman), and Brahman in which steers had 0/32 to 9/32nd Angus genetics (0% Angus/100% Brahman). All steers were weaned at 210 days of age and reared under

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the same conditions until harvest. Steers were harvested at a common compositional endpoint of 0.5 in. of back fat over the 12th/13th rib. Following a 24-hour chill time, a 3 in. thick loin roast extending from the 13th rib towards the posterior end of the loin was collected from each carcass and wet-aged 14 days in a vacuum bag at 35°F. After aging, three 1 in. steaks were fabricated from each roast. Steak one was utilized for objective tenderness analysis by Warner-Bratzler shear force, steak two was utilized for trained sensory panel analysis, and steak three was used to measure myofibrillar protein degradation and collagen characteristics. Steaks utilized for Warner-Bratzler shear force were cooked on open-hearth grills (Model 450-A, Farberware, Yonker, NY) to an internal temperature of 160°F, cooled overnight at 35°F, and 6, 1 in. cores were removed perpendicular to the muscle fiber and sheared once. Sensory panel steaks were cooked in a similar manner as described above, but were then cut into 1 in. cubes and presented to trained sensory panel. Sensory panelists evaluated steaks for tenderness, juiciness, beef flavor, connective tissue amount tissue (1 = extremely tough, extremely dry, extremely bland, abundant; 8 = extremely tender, extremely juicy, extremely intense, none, and off-flavor (1 = extremely intense; 6 = none). Protein degradation analyses consisted of Western Blot quantification (Figure 1) of degradation products of desmin (38 kDa band) and troponin-T (36, 34, and 30 kDa band). Collagen cross-links were extracted by acid hydrolysis and the hydroxylysyl pyridinoline cross-link was quantified utilizing a commercial ELISA kit. The perimysial collagen fraction was extracted from the muscle, samples were dried, and subjected to differential scanning calorimetry to determine the peak temperature at which the perimysial collagen melts.

Results and Discussion

Because of the well documented body of literature on Brahman genetic influence on cooked meat characteristics, objective and subjective measures were evaluated (Table 1). As the percentage of Brahman genetics increased, strip loin steak thaw loss increased, but there was no effect ($P=0.14$) on cook loss. In agreement with data from previous literature, as the percentage of Brahman genetics increased Warner-Bratzler shear force increased (linear, $P<0.01$), indicating that increasing Brahman genetics decreases tenderness of steaks. Further, as percentage Brahman genetics increased, sensory panel scores of strip loin steak tenderness, connective tissue, and juiciness decreased (linear, $P<0.01$), indicating that steaks were tougher, had more connective tissue, and were less juicy. Brahman genetics had no effect on beef flavor or off-flavor scores ($P>0.35$).

Tenderness is influenced by two distinct components, myofibrillar protein degradation and collagen solubility. Steaks from steers with a greater percentage of Brahman genetics had decreased intensity of 38 kDa desmin, 34 kDa troponin-T, and 30 kDa troponin-T degradation bands (Table 2; linear, $P<0.03$). In contrast to these results, increasing Brahman genetics increased (linear, $P=0.04$) intensity of 36 kDa degraded troponin-T band. Decreased intensity of the desmin degradation band and the two smaller troponin-T degradation bands, and increased intensity of the troponin-T 36 kDa band signifies less myofibrillar protein degradation in steaks from steers with a greater percent of Brahman genetics. This decrease in myofibrillar protein degradation is likely driving the decreases in objective tenderness and sensory panel tenderness of steaks from steers with a greater percentage of Brahman genetics. Sensory panelists also detected increases in the amount of collagen within strip loins steaks as the percentage of Brahman genetics increased. There was no effect ($P=0.14$) of Brahman genetics on

amount of the hydroxylysyl collagen crosslink, but as Brahman genetics increased, peak temperature to melt perimysial collagen from steaks tended (linear, P=0.07) to increase. Although there was no difference in the collagen crosslink measured, it is probable there may be other crosslinks that are increased in steaks from steers with greater Brahman genetics. This may be a cause of the increased melting temperature of the perimysial collagen.

Implications

As in most published literature, as the percentage of Brahman genetics increased, steak tenderness decreased. This decrease in tenderness is likely caused by a decrease in myofibrillar protein degradation, but is not caused by the amount of the hydroxylysyl pyridinoline crosslink. However, it does appear the increase in connective tissue detected by panelists in steaks from steers with greater Brahman genetics may be because the collagen was not as soluble due to a tendency for increased melting temperature of the perimysial collagen. Further research is needed to elucidate the cause of the heat stability of collagen from steaks of steers with greater Brahman genetics.

Table 1. The effect of Angus and Brahman genetics on objective and subjective measures of cooked meat tenderness of strip loin steaks wet-aged 14 days postmortem

	Angus/Brahman,[1] %					P-value	
Item	100/0	62.5/32.5	50/50	0/100	SEM	Linear	Quadratic
Objective measures							
Shear force, lb	37.22	38.23	40.78	43.46	2.47	0.01	0.86
Thaw loss, %	1.07	1.99	1.51	2.14	0.70	0.01	0.44
Cooking loss, %	15.73	13.80	15.39	14.21	1.43	0.14	0.54
Subjective measures[2]							
Tenderness	6.30	5.69	6.05	5.30	0.18	0.01	0.81
Juiciness	6.27	5.92	5.99	5.84	0.12	0.01	0.22
Beef flavor	5.75	5.70	5.87	5.68	0.09	0.56	0.35
Connective tissue	6.76	6.49	6.64	6.11	0.21	0.01	0.49
Off-flavor	5.86	5.85	5.85	5.87	0.05	0.84	0.73

[1] Steers (n = 131) were classified into 4 categories based on percentage of Angus and Brahman genetics. The breed groups were: 100% Angus/0% Brahman, 62.5% Angus/37.5% Brahman (Brangus), 50% Angus/50% Brahman, and 0% Angus/100% Brahman.
[2] Tenderness, juiciness, beef flavor, and connective tissue (1 = extremely tough, extremely dry, extremely bland, abundant; 8 = extremely tender, extremely juicy, extremely intense, none). Off-flavor (1 = extremely intense; 6 = none).

Table 2. The effect of Angus and Brahman genetics on protein degradation and collagen characteristics of strip loin steaks wet-aged 14 days postmortem

	Angus/Brahman,[1] %					P-value	
Item	100/0	62.5/32.5	50/50	0/100	SEM	Linear	Quadratic
Protein degradation[2]							
Intact desmin 55 kDa band	0.96	0.86	0.81	1.05	0.34	0.51	0.11
Degraded desmin 38 kDa band	1.42	1.27	0.97	0.76	0.69	0.01	0.89
Intact troponin-T 40 kDa band	1.30	0.94	1.01	1.11	0.44	0.34	0.04
Degraded troponin-T 36 kDa band	0.79	0.94	0.93	2.03	0.53	0.04	0.47
Degraded troponin-T 34 kDa band	0.74	0.70	0.46	0.19	0.41	0.01	0.30
Degraded troponin-T 30 kDa band	1.40	1.54	1.39	0.94	0.78	0.03	0.13
Collagen							
Collagen crosslink[3]	1644	1719	1747	1408	156	0.14	0.14
Perimysial collagen[4]	131.3	121.2	135.3	143.8	4.9	0.07	0.17

[1] Steers (n = 131) were classified into 4 categories based on percentage of Angus and Brahman genetics. The breed groups were: 100% Angus/0% Brahman, 62.5% Angus/37.5% Brahman (Brangus), 50% Angus/50% Brahman, and 0% Angus/100% Brahman.
[2] Protein degradation data measured in arbitrary units.
[3] Hydroxylysyl pyridinoline crosslink measured in ng/g tissue.
[4] Peak differential scanning calorimetry melting temperature in °F.

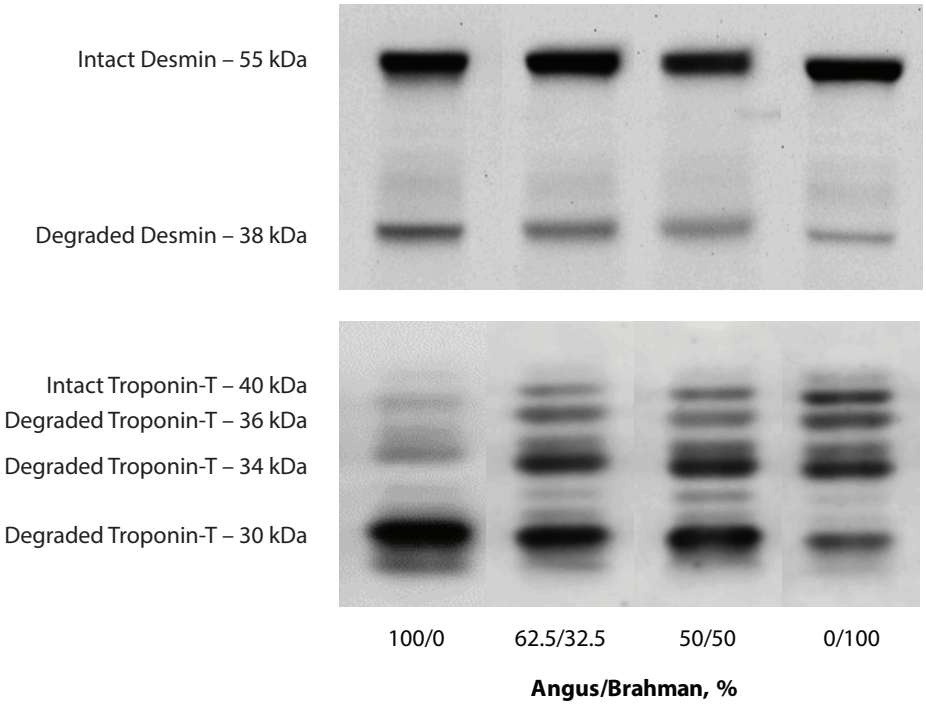

Figure 1. Representive western blots of desmin and troponin-T degradation of strip loin steaks from Angus (100% Angus/0% Brahman), Brangus (62.5% Angus/32.5% Brahman), Half-Blood (50% Angus/50% Brahman), and Brahman (0% Angus/100% Brahman) steers.