

Association between carcass and meat quality traits and phenotypic residual feed intake, breed composition, and temperament in Angus-Brahman multibreed cattle

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SUMMARY

The objective of this research was to study the association between 6 carcass and 6 meat quality traits and phenotypic residual feed intake (RFI), breed composition, and exit velocity (EV) using 170 steers ranging from 100% Angus (A) to 100% Brahman (B). Calves were from the Beef Research Unit in Gainesville, FL. After weaning they were transported to a GrowSafe automated feeding facility in Marianna, FL. Calves were randomly assigned to pens by sire group (1 = A, 2 = ¼ A ¼ B, 3 = Brangus, 4 = ½ A ½ B, 5 = ¾ A ¾ B, and 6 = B) and sex (bull, heifer, and steer) and feed concentrate during a 21-d adjustment and a 70-d trial periods. Collected data included individual daily feed intake, and biweekly weights and exit velocities. At the conclusion of the feeding trial, steers were taken to a commercial feedlot (King Ranch Feedyard, Kingsville, TX), and subsequently slaughtered at Sam Kane Beef Processors, Corpus Christi, TX. Phenotypic RFI was estimated as the difference between actual and expected feed intake. Traits were analyzed using single-trait mixed linear models. Fixed effects were contemporary group (year-pen), RFI group, age of calf, B fraction of calf nested within RFI group, heterozygosity of calf, and mean EV. Random effects were sire and residual. The RFI groups were: high (RFI > 0.85 kg), medium (0.85 kg ≤ RFI ≤ 0.85 kg), and low (RFI < -0.85 kg; SD = 1.7 kg). Hot carcass weight, longissimus muscle area, fat thickness, marbling, and tenderness tended to decrease, whereas shear force tended to increase as Brahman fraction increased. High and medium RFI calves had higher marbling and quality grade than low RFI calves. High RFI calves had smaller longissimus muscle area and higher yield grade than low RFI calves. Exit velocity was non-significant for all traits.

INTRODUCTION

Increasing production costs emphasize the need to identify and multiply cattle that are efficient at converting feed into beef of desirable quality. Factors that may influence quantity and quality of meat as well as efficiency of beef production include breed composition (additive and nonadditive genetic effects), residual feed intake (RFI; actual minus expected feed intake), and temperament (exit velocity, EV). The vast majority of commercial beef cattle in the Southern region of the US is composed of Brahman (B) crosses with *Bos taurus* breeds such as Angus (A). The objective was to study the association between 8 carcass and 6 meat sensory traits and breed group (Angus (A), Brahman (B), Brangus, ¼ A ¼ B, ½ A ½ B, and ¾ A ¾ B), residual feed intake (RFI) group (high: RFI > 0.85 kg; medium: 0.85 kg ≤ RFI ≤ 0.85 kg; low: RFI < -0.85 kg; SD = 1.7 kg), and exit velocity (EV) in 170 steers from the Angus-Brahman herd of the University of Florida (UF).

MATERIALS AND METHODS

Animals, preweaning management, and nutrition. Steers (n = 170) were born in 2006 and 2007, progeny of a dalliel mating of 33 sires and 143 dams from 6 breed groups (1 = Angus, 2 = ¼ A ¼ B, 3 = Brangus, 4 = ½ A ½ B, 5 = ¾ A ¾ B, and 6 = Brahman). Table 1 shows numbers of steers per breed-group-of-sire x breed-group-of-dam combination. Cows were synchronized with a progesterone-releasing device (CIDR[®], Pfizer Animal Health) for 7 d (March), followed by an injection of PGF_{2α} (5 ml of LUTALYSE[®], Pfizer Animal Health), artificially inseminated twice, then placed with a natural service sire for 60 d (6 breeding groups with one sire per breed group). Calves were born in Spring and raised at the UF Beef Research Unit (BRU) until weaning. After weaning, calves were pre-conditioned for 4 wk using concentrate (1.6 kg to 3.6 kg; 488 Pellet, Medicated Weaning Ration, Lakeland Animal Nutrition, Lakeland, Florida, and soy hull pellets), hay, pasture, and free choice mineral (UF University Special Hi-Cu Mineral, University of Florida, Animal Science Department, Gainesville).

Breed group of dam	Breed group of sire						
	Angus	% A % B	Brangus	% A % B	% A % B	Brahman	All
Angus	17	2	2	2	3	4	30
% A % B	6	4	8	5	3	4	30
Brangus	2	1	18	1	1	2	25
% A % B	5	10	10	6	5	5	41
% A % B	5	3	2	4	1	2	17
Brahman	0	0	0	0	0	27	27
All	35	20	40	18	13	44	170

Management, nutrition, and data collection at the UF Feed Efficiency Facility. Calves were transported to the UF GrowSafe automated feeding facility (Marianna, Florida) in September. Animals were randomly allocated to 10 pens of 20 calves each in 2006, and to 14 pens of 13 to 14 calves each in 2007, by sire group (1 = A, 2 = ¼ A ¼ B, 3 = Brangus, 4 = ½ A ½ B, 5 = ¾ A ¾ B, and 6 = B) and sex (bull, heifer, and steer). Pens were 108 m², and had 2 GrowSafe feed nodes. The 2006 concentrate diet was composed of whole corn, soybean hulls, corn gluten feed, cottonseed hulls, and a protein, vitamin, and mineral supplement (PRM, Bainbridge, GA). The 2007 diet had a higher fiber content (chopped bermudagrass instead of soybean hull pellets). The concentrate had a DM, CP, NEM, and NEG of 91.2%, 17.3%, 1.7 mcal/kg DM, and 1.2 mcal/kg DM in 2006, and 90.0%, 14.1%, 1.5 mcal/kg DM, and 0.9 mcal/kg DM in 2007. The pre-trial adjustment period was of 21 d, and the trial period lasted 70 d. GrowSafe software recorded individual feed intake in real-time. Weights and exit velocity were taken every 2 weeks. Upon completion of the feed efficiency trial, steers were sent to a South Texas feedlot (King Ranch Feedyard, Kingsville, TX), and commercially slaughtered at approximately 14 mm of fat over the longissimus muscle (Sam Kane Beef Processors, Corpus Christi, TX).

Residual Feed Intake and Temperament. Residual feed intake was computed as actual minus expected feed intake (Koch et al., 1963; Arthur et al., 2001; Archer et al., 2007). Expected feed intake was a linear function of average daily gain and metabolic mid-weight. Average daily gain was computed as regression of weight on test days. Metabolic mid-weight was estimated mid-weight (estimated initial weight plus average daily gain times 365) to the power of 0.75. Temperament was measured as exit velocity (EV) from the chute (m/sec).

Carcass and Meat Quality traits. Carcass traits were: hot carcass weight (HCW, kg), dressing percent (DP, %), longissimus muscle area (LMA, cm²), fat thickness between the 12th and 13th ribs (FT, cm), kidney, pelvic, and heart fat (KPH, % of carcass weight), and marbling score (MS; USDA scores: 200 = traces, 300 = slight, 400 = small, 500 = modest, 600 = moderate). Meat quality traits were: Warner-Bratzler shear force (SF, kg), tenderness score (TS; 1 = extremely tough, 2 = very tough, 3 = moderately tough, 4 = slightly tough, 5 = slightly tender, 6 = moderately tender, 7 = very tender, 8 = extremely tender), juiciness (JU; 1 = extremely dry to 8 = extremely juicy), flavor (FL; 1 = extremely bland to 8 = extremely intense), thaw loss (TL, %; 100°(Frozen wt - Thawed wt)/Thawed wt), and cooking loss (CL, %; 100°(Thawed wt - Cooked wt)/Cooked wt).

Statistical analysis. Traits were analyzed using single-trait mixed models (SAS Proc Mixed). Fixed effects were contemporary group (year-pen), RFI group (1 = high = RFI > 0.85 kg, 2 = medium = 0.85 kg ≤ RFI ≤ 0.85 kg, 3 = low = -0.85 kg; SD = 1.7 kg), age of calf, B fraction of calf within RFI group, heterozygosity of calf, and mean EV. Random effects were sire and residual (zero mean, common variance, uncorrelated). Procedure GLOT of SAS was used to graph least squares means by RFI group and breed group of calf.

RESULTS AND DISCUSSION

Residual feed intake. Residual feed intake group was important for LMA ($P < 0.02$) and MS ($P < 0.0002$). High RFI (less efficient) steers had smaller LMA (11.0 ± 3.8 cm²; $P < 0.005$) than low RFI (more efficient) steers. Marbling score was higher in steers from the high RFI (116.0 ± 34.0 units; $P < 0.0009$) and medium RFI (108.0 ± 29.9 units; $P < 0.0004$) groups than those in the low RFI group.

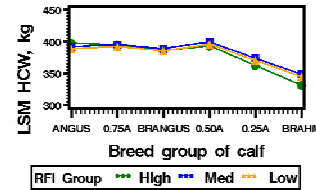
Breed composition. Coefficients of regression of carcass and meat quality traits on B fraction of steers within RFI group were negative for HCW ($P < 0.006$), LMA ($P < 0.0001$), FT ($P < 0.02$), MS ($P < 0.0001$), and TS ($P < 0.0001$), but positive for SF ($P < 0.0003$). This indicated that steers with higher B fractions tended to have higher HCW, smaller LMA, thinner FT, lower MS, lower TS, and higher SF than steers with higher A fractions.

Heterosis. The coefficient of regression of LMA on heterozygosity was positive ($7.9 \text{ } 3.7$ cm²; $P < 0.035$) indicating that steers with higher levels of heterozygosity tended to have larger LMA.

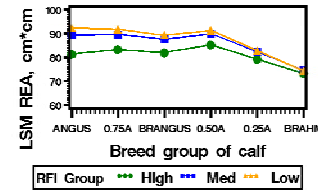
Temperament. Exit velocity had no effect on either carcass or meat quality traits.

Trait	P > F	High RFI	Medium RFI	Low RFI
HCW	0.0006	-65.7 ± 22.1 kg	-42.4 ± 23.5 kg	-43.3 ± 18.2 kg
LMA	0.0001	-8.08 ± 5.0 cm ²	-14.6 ± 5.3 cm ²	-17.9 ± 4.1 cm ²
FT	0.0207	-1.08 ± 0.4 cm	-0.4 ± 0.4 cm	-0.1 ± 0.3 cm
MS	0.0001	-170.7 ± 44.1 units	-182.2 ± 46.7 units	-38.7 ± 36.3 units
SF	0.0003	1.3 ± 0.3 kg	0.6 ± 0.3 kg	0.2 ± 0.3 kg
TS	0.0001	-0.9 ± 0.3 units	-1.7 ± 0.3 units	-0.9 ± 0.3 units

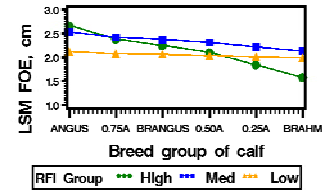
Hot Carcass Weight



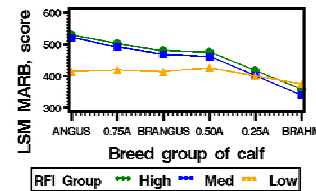
Ribeye Area



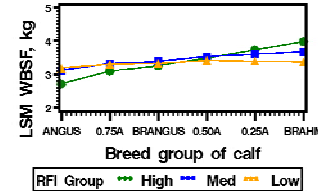
Fat Over Ribeye



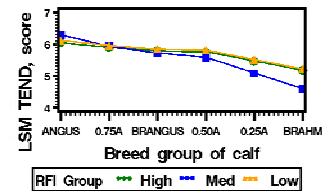
Marbling



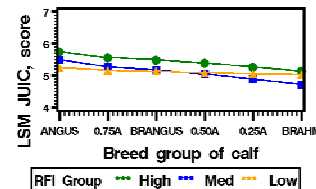
Warner-Bratzler Shear Force



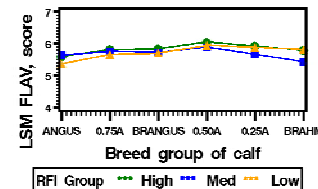
Tenderness



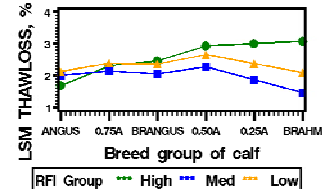
Juiciness



Flavor



Thaw loss



FINAL REMARKS

Steers in the high RFI group (less efficient) tended to have smaller longissimus muscle area and higher marbling score than steers in the low RFI group (more efficient). Hot carcass weight, longissimus muscle area, fat thickness, marbling, and tenderness tended to decrease, whereas shear force tended to increase as Brahman fraction increased. Longissimus muscle area tended to increase as levels of heterozygosity increased. Exit velocity had no measurable effect on either carcass or meat quality traits.

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