Temperament classification affects tenderness of steaks from Simmental x Angus cross steers.

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Abstract – The objective of this study was to determine if temperament impacted growth rate of an animal and tenderness of beef steaks, and could blood lactate be used as an objective measurement of temperament. Simmental x Angus steers were evaluated for exit velocity, blood lactate and docility score (n=154), humanely harvested and tenderness of steaks evaluated (n=30). Steers with a higher ADG resulted in steaks with lower shear force values (P=0.02) than either medium or slow ADG. Steers with high and low blood lactate concentrations resulted in more tender steaks than steaks from steers with medium blood lactate. Steers that exited the chute more quickly tended to result in steaks that had higher shear force values (P=0.06). Results suggest that temperament as measured by exit velocity and blood lactate along with growth rate contribute to variation in tenderness.

I. INTRODUCTION

Variation in meat quality and tenderness is a challenge for the meat industry (1). Many ante and post-mortem factors contribute to this variation including meat pH either rate or extent of decline. Decline of pH postmortem is influenced by numerous factors including temperature, genetics and anti-mortem stress. Apple and co-workers (2) reported increased consumption of glycogen by muscle and altered pH decline postmortem in response to restraint. Stress response results in increased concentrations of epinephrine and cortisol which result in increased gluconeogenesis, proteolysis and increased sensitivity of lipids to lipolytic hormones (3). This response generally leads to increased anaerobic metabolic processes in the muscle and, subsequently, excessive lactic acid in the blood. Curley et al. (4) reported that exit velocity was related to cortisol levels and suggesting the use of exit velocity as a measure of stress during handling.

Café and co-workers (5) evaluated persistent assessments of temperament on productivity, carcass characteristics and meat quality traits (color and tenderness). They found in general, cattle with more excitable temperaments as measured by exit velocities and chute scores had consistently lower feed intakes and slower growth rates, which resulted in smaller carcasses with less fat cover and poorer objective meat quality characteristics. Other researchers also reported decreased growth rates (average daily gain) in animals with more excitable temperaments (6, 7). Along with decreased growth rates, researchers reported that meat from animals with more excitable temperament had higher shear force values (5, 8, 9) and were more likely to produce carcasses that were borderline dark cutters (8). This relationship was seen to be stronger in *bos indicus* breeds than *bos taurus* breeds.

II. MATERIALS AND METHODS

Data was collected in compliance with Montana State University Agriculture Animal Care and Use Committee under the Animal Care approval number 2013-AA02. Angus x Simmental calves (n=154) were evaluated for temperament using chute scores, blood lactate and chute exit velocity measurements. The chute scores, ranging from 1 to 6 were assigned by a single individual at all handling times using the scoring system used by the Beef Improvement Federation (10).

Blood lactate concentration was analyzed with a blood lactate meter (Lactate Pro, Arkray Inc, Minami-Ku, Kyoto, Japan) (mmol/L of lactate). Steers were caught in a head gate when they were handled through the chute to be either weighed or vaccinated. After blood for lactate measurement and weight were obtained, animals were allowed to leave the chute and the exit velocity was measured with a Farmtek timer system. The initial “infrared” gate was placed

1.824 meters in front of the chute and the final gate was 1.824 meters from the initial gate. Exit speed was recorded and meters per second were calculated for statistical analysis (4).

All steers received the same feed, exposed to the same environment, management and handling throughout their lifespan in an attempt to eliminate confounding variables. The temperament was assessed for all of the steers at weaning, two weeks later when vaccine boosters were administered, when steers were processed into the feedlot, and when weighed half way through the finishing phase just prior to ultrasound assessment to determine harvest day (USDA Choice endpoint). Average Daily Gain (ADG) was calculated using an adjusted 205 weaning weight and weight at midpoint through the finishing phase. (weight at midway through feedlot phase – adjusted weaning weight / 140 days).

The animals were harvested on the same day under federal inspection. A subsample of 15 steers with a low average daily gain (ADG) and a subsample of 15 steers with high average daily gain (ADG) from selected sires were chosen and strip loins collected from each carcass from the designated steers. The loin samples were collected 36 hours after slaughter from the carcasses, and transported to Montana State University (4° C), where loins were cut into steaks and the steaks aged for 3, 7, 14, and 21 days. After samples were aged, they were frozen for further analyses. The samples collected were used to evaluate shear force tenderness and myofibrillar fragmentation index.

Steaks for shear force were thawed at 4°C for 24 h, placed under an electric broiler 10 cm from the heat source and cooked to a final internal temperature of 70°C. Five to eight samples (1.27 × 1.27 × 2.54 cm) from each steak were sheared perpendicular to the fiber direction with a TMS 30 Food Texturometer (Food Technology Corp., Rockville, MD) fitted with a Warner-Bratzler shear attachment (11).

Myofibril fragmentation index (MFI) was determined following the procedures reported by Culler et al (12), as modified by Hopkins et al. (13). Two samples per steer were analyzed and the average of the MFI calculated was used for statistical analyses.

To identify the growth, speed and lactate classifications the mean and standard deviation was calculated using 154 animals for all temperament measurements. The means plus one standard deviation were designated “high” growth, “fast” speed or “high” lactate, and the mean minus one standard deviation represented “low growth, slow speed or low lactate. The rest were designated as medium for the classification. The GLM procedure of SAS was used to analyze tenderness data. The classifications described above were used along with days aged as the independent or class variables. Interactions between days of ageing and growth, speed and lactate class were also tested. The LSMEANS procedure of SAS was used to calculate means. Dunnetts test was used to separate means. Pearson correlations were calculated on all data. Data were considered significant when the P-value was less than or equal to 0.05.

III. RESULTS AND DISCUSSION

Growth classification had a significant effect on shear force values but no effect on MFI. No significant interaction was found between postmortem time and the different temperament or growth classifications. The steers with faster growth rate had steaks with significantly lower shear force values (Table 1). Oddy et al. (14), and Purchas et al., (15) reported that rapid growth over the lifetime of an animal often resulted in lower shear force values. This could be explained by more rapid growth rate resulting in differences in structural and cross linking of the collagen matrix, along with altered proteolytic activity which influences the rate of protein accretion.

Blood lactate classification also significantly affected shear values ($P = 0.02$). The steaks from steers with medium blood lactate levels were significantly more tender than steaks from steers with high blood lactate. And shear force values of steaks from low and high blood lactate classifications were not different while steads from steers with a medium blood lactate concentration were less tender. This could indicate that high levels of lactate in the muscle ante mortem altered the rate of pH decline enough to impact tenderness. Multiple researchers have reported that altered rates of pH decline postmortem can affect the tenderness of steaks (15, 16).

Table 1: Effect of growth, exit speed and blood lactate classification on myofibrillar fragmentation index (MFI) and shear force values (least squares means).

Class	MFI	Shear
Growth Rate[1]		
Fast	41.4	55.7[b]
Slow	37.4	66.0[a]
P-Value	0.16	0.02
Exit Speed[1]		
Fast	39.6	69.3
Medium	42.1	60.5
Low	36.5	55.7
P-Value	0.27	0.07
Blood Lactate[1]		
High	39.5	57.1[b]
Medium	39.7	67.9[a]
Low	39.5	60.5[ab]
P-Value	0.97	0.02

[1]Classifications for growth rate, exit speed and blood lactate are based on ± one standard deviation from the mean. Plus one standard deviation is fast or high and minus one standard deviation is low. The rest of the steers were classified as medium.
[a,b] means within a column with different superscripts are significantly different P<0.05

A strong trend was noted for exit speed classification to affect shear values. On average steaks from animals that left the chute at a fast speed tended to have higher shear force values than steaks from steers leaving the chute at a medium or slow velocity. This agrees with the work of Cafe et al, (5), Voisinet et al, (8), and Behrends et al, (7) which indicated that steaks from cattle with more excitable temperaments as measured by chute score and exit velocity, had higher shear force values.

Temperament scores were significantly correlated (Table 2). Exit speed was correlated to docility measurement (r = 0.57, P =0.001) and lactate concentrations (r = 0.46, P = 0.01). Temperament measurements were not however, strongly related to tenderness. A significant correlation (r = 0.38, P = 0.04) was observed between the average exit speed and the shear force values after 3 days of postmortem ageing. This suggested that steers with a faster exit speed resulted in meat with higher shear force values. This was supported by (9) who found as temperament increased from calm to excitable, Warner-Bratzler shear force values increased, therefore, concluding temperament had a significant effect on tenderness (9).

As expected a significant correlation ($P \leq 0.02$) was seen between shear force values after 7, 14 and 21 days of postmortem ageing (Table 2). This indicated that if there was a high shear value after 7 days of postmortem ageing there was a higher value after 14 and 21 days of ageing. This suggests that even if shear force values become more similar with postmortem ageing, if they are higher after 3 days of ageing, it will be higher after 21 days of ageing, again contributing to variation in samples in the marketplace.

Table 2: Simple correlations coefficients between (P-value) average docility scores, exit velocity and blood lactate of steers and carcass tenderness measurements (n=30).

	DAVE	SPEED	LAVE	SHR3	SHR7	SHR14
DAVE[1]	1					
SPEED[1]	0.57 (0.001)	1				
LAVE[1]	0.59 (0.0006)	0.46 (0.01)	1			
SHR3[1]	0.15 (0.44)	0.38 (0.04)	0.16 (0.39)	1		
SHR7[1]	-0.11 (0.58)	0.10 (0.60)	0.005 (0.97)	0.70 (<0.0001)	1	
SHR14[1]	-0.10 (0.61)	0.14 (0.45)	-0.005 (0.98)	0.31 (0.09)	0.33 (0.07)	1
SHR21[1]	-0.24 (0.20)	-0.04 (0.84)	-0.12 (0.53)	0.39 (0.03)	0.53 (0.002)	0.26 (0.17)

[1]DAVE= average docility score, SPEED= average exit velocity measurement, LAVE= average blood lactate, SHR= shear force value, 3, 14 and 21 indicate days of ageing postmortem of steaks for shear force

IV. CONCLUSIONS

Growth rate and blood lactate classifications indicated that tenderness was impacted by the altered metabolic environment that occur during the growing phase of animals. Combining temperament data with tenderness data reported here indicate that if an animal is temperamental based on exit scores and lactate concentrations before harvest, this, could predispose a postmortem process that results in a less tender product. Utilizing a simple objective measure of temperament like the lactate meter could possibly lead to decreasing variations in temperament within a producers herd and could lead to less variation in the tenderness a consumer will encounter. However, more research is needed to determine what the optimum blood lactate. Improving the ability of producers to evaluate temperament could result in more consistent tenderness of steaks in the marketplace culminating in a greater consumer satisfaction.

ACKNOWLEDGEMENTS

Research was partially funded by the Bair Ranch Foundation and Montana Experiment Station. The cooperation of Chappell Feedlot and American Simmental Association is also appreciated.

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