EFFECT OF GROWTH RATE OF STEERS ON CARCASS SHEAR FORCE VALUES

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Abstract – Reducing variation in tenderness is a goal for the meat industry. The objective was to determine if different growth patterns impact carcass characteristics and tenderness. Simmental x Angus steers (n = 18) reared under similar conditions, fed in the same pen at the feedlot, were allocated into fast (n = 9) and slow (n = 9) growing groups based upon three sets of weight data. After slaughter, carcass data were obtained. The striploin was removed, cut into steaks, and aged for 1, 3, 7, 14, and 21 days. For each aging period, one steak per steer underwent shear force. Carcass weight (P < 0.0001) and ribeye area (P = 0.0093) were significantly affected by growth rate. Shear force was significantly affected by length of aging (P=0.0002), but not by growth rate (P = 0.4196) nor was there a significant interaction between growth rate and length of aging (P = 0.6555). Even though the shear force x growth rate finding was not statistically significant, shear force of steaks from fast growing animals were, on average, less than the shear force of steaks from slow growing animals. More research is warranted to elucidate the effect of growth rate on variation in tenderness.

Key Words – beef, carcass, growth, tenderness

I. INTRODUCTION

Beef tenderness is a characteristic that influences consumer satisfaction [1], consumer willingness to re-purchase [2], and amount of money a consumer is willing to spend [3]. However, the United States meat industry has a long history of tenderness variation in meat purchased [3,4]. This variation in tenderness limits product acceptability and leads to product dissatisfaction [5]. It is widely accepted that in order to retain customers, it is necessary for the industry to produce a consistently tender product [1,4,6]. Tenderness is linked to protein degradation postmortem [7] and the variation of tenderness among animals of similar age has been attributed to differences in the rate of protein degradation [8]. The effect of growth rate on tenderness is a highly researched and contested topic. In lamb, callipyge, a genetic mutation causing increased muscular hypertrophy has been shown to decrease tenderness [9]. Boles *et al.* [10] reported cattle of Continental descent had larger ribeye areas, implying increased muscle growth. Furthermore, these researchers reported steaks from cattle of Continental descent had significantly higher shear force values than steaks from cattle of British descent, suggesting growth rate might have an impact on tenderness. Other studies altering growth rate with nutrition have shown no effects of growth rate on tenderness [11, 12, 13]. Perry and Thompson [14], however, reported that an increased growth rate in individual animals resulted in increased sensory tenderness. Other researchers have also reported increased tenderness in faster growing animals [15,16,17]. Due to equivocal findings, the objective of this study was to determine if different growth patterns had an impact on carcass characteristics and tenderness of beef, with the emphasis on evaluating the effect of growth rate based on genetic predisposition. It was hypothesized that steers exhibiting a faster rate of growth would result in steaks with greater tenderness than observed in slow-growing steers.

II. MATERIALS AND METHODS

Eighteen sire-verified, Simmental x Angus steers from the Bair Ranch in Martinsdale, MT, were selected from a group of 132 steers reared under similar conditions. Based upon the ranking of the steers at three different weight measurements (adjusted weaning weight, weight at entry into the feedlot, and weight taken at time of ultrasound), nine steers that were ranked highest in multiple weight times were selected as the fast-growing cattle. Conversely, nine steers that were ranked lowest in multiple weight times were selected as the slow-growing cattle. The cattle were fed at Chappell Feedlot in Chappell, Nebraska, for six months until the slow-growing steers averaged Choice quality grade, as predicted via ultrasound technique. All steers were in the same pen at the feedlot and were fed a 94% concentrate, 6% roughage ration containing 14.58% crude protein, and 0.61 Mcal/lb NEg. The steers were trucked to Columbus, MT and, after a 24-hour recovery period, were harvested following normal industry practices. Carcass data (hot carcass weight, fat thickness, ribeye area, maturity, and marbling) were collected by an experienced evaluator after a 24-hour chill period and the striploin (NAMP 180) [18] was removed from the left side of the carcass and sliced into 2.54 cm thick steaks. The steaks were vacuum packaged and aged at 4ºC for 1, 3, 7, 14, or 21 days, then frozen. One steak per steer per aging period was thawed at 4ºC for 24 hours prior to cooking. The steak was weighed pre- and post-cooking to determine cook loss [raw weight (g) – cooked weight (g) / cooked weight (g) x 100]. A minimum of five square cores (1.27 x 1.27 x 2.54 cm) were removed parallel to the fiber direction from each cooked, cooled steak for shear force evaluation. Samples were sheared once perpendicular to the fiber direction with a TMS 30 Food Texturometer fitted with a Warner-Bratzler shear attachment [10]. The average of the samples sheared was used for statistical analysis. Carcass data and shear force was analyzed using General Linear Model procedure of SAS. Shear force fixed effects included growth rate, days of aging, and the interaction of growth rate and aging. Significance was determined *a priori* $P < 0.05$.

III. RESULTS AND DISCUSSION

In carcasses of fast-growing steers, findings indicated a significant increase in hot carcass weight ($P < 0.0001$) and ribeye area ($P = 0.0093$), while shear force was not significantly affected ($P = 0.4196$) by growth rate (Table 1). Fat thickness, % KPH, yield grade, marbling, and quality grade did not differ ($P \geq 0.4795$) between growth rates (data not shown).

Table 1 Effect of growth rate on certain carcass characteristics and shear force

Growth Rate	Hot carcass wt, kg	LD area, cm^2	Shear force, N
Fast	416.2	32.0	74.6
Slow	311.5	29.21	77.2
P-value	<0.0001	0.0093	0.4196

1 N = 9.81 kg

The increase in hot carcass weight and ribeye area differs from results reported by Loken *et al.* [12], indicating no difference in these characteristics between low and high gain groups of cattle when using Angus cross steers. On the other hand, Boles *et al*. [10] reported a difference in hot carcass weights and muscling when comparing Simmental and Angus cattle. Simmental cattle are considered later maturing and have been reported to produce larger hot carcass weights and ribeye areas [19]. The steers used in the current study were Simmental x Angus crosses and this may have contributed to the differences in carcass weight differences observed in this study and by Loken *et* al. [12]. The lack of significant difference in shear force between the fast and slow growing cattle in the current study agrees with studies by Allingham *et al*. [11], Loken *et al*., [12] and Calkins *et al*. [13], reporting no statistical difference in shear force. Conversely, Boles *et al.* [10] reported an increase in shear force in steaks from animals with larger carcass weights and rib eye areas. The increase in shear force with increased muscling agrees with reports of decreased tenderness associated with callipyge mutation in sheep [9]. Consistent with this theory of increased muscling leading to increased shear force, the lack of a significant difference in hot carcass weights, ribeye area, and shear forces in the Loken *et al*. study [12] would support the supposition that increased muscling might affect tenderness. Data reported by Allingham *et al*. [11] also indicated no significant difference in shear force among animals with similar muscling. However, in the current study, there was increased muscling associated with a faster growth rate, as shown by increased carcass weight and increased rib eye area but no significant difference in shear force values. Following the aforementioned trend, an increased shear force would be expected to be associated with increased muscling, but the findings did not support this premise.

Table 2 Effect of growth rate and extent of post-mortem aging on shear force

		Shear Force, N
Days aged postmortem		
1		90.6^{a}
3		77.7^{b}
7		73.1^{b}
14		69.8^{b}
21		68.1^{b}
	P-value	0.0003
Growth rate x day interaction		
Fast		
1 day		93.4
3 day		73.4
7 day		73.4
14 day		68.0
21 day		64.6
Slow		
1 day		87.9
3 day		81.9
7 day		72.8
14 day		71.6
21 day		71.6
	P-value	0.6555

1 N = 9.81 kg

[a,b]Means within a column without a common superscript differ ($P < 0.05$)

As expected, shear force values were significantly impacted (P = 0.0003) by length of postmortem aging (Table 2). Increased postmortem aging times have long been known to increase tenderness [20] and protein degradation [21]. Although the growth rate x day interaction was not statistically significant for shear force values (P = 0.6555), the samples from fast growing animals indicated a more rapid drop in peak shear force value while reaching a similar value as the samples from slow growing animals by 21 days postmortem. Unpublished data from Boles *et al*. also found a faster tenderization in steaks from faster-growing cattle as indicated using the myofibril fragmentation index and as visualized on SDS page gels.

It appears that there is potentially a mechanism in faster-growing cattle that allows the carcass to tenderize more quickly, but more research is warranted to determine the mechanism and the degree it is contributing to variation in tenderness.

IV. CONCLUSION

Decreasing the variability of tenderness has been suggested as a method to insure customer satisfaction and the intent to re-purchase. Differences in growth rate caused a significant increase in hot carcass weight and muscling, but did not cause a significant difference in shear force value. Findings suggest that more research is warranted to determine if there is a difference in the rate of tenderization in carcasses between fast- and slow-growing cattle. This knowledge may aid the beef industry in reducing the variation in tenderness.

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REFERENCES

1. Shackelford, S.D., Wheeler, T.L., Meade, M.K., Reagan, J.O., Byrnes, B.L. & Koohmaraie, M. (2001). Consumer impressions of tender select beef. Journal of Animal Science 79:2605-2614.
2. Archile-Contreras, A.C., Mandell, I.B. & Purslow, P.P. (2010). Disparity of dietary effects on collagen characteristics and toughness between two beef muscles. Meat Science 86:491-497.
3. Miller, M.F., Carr, M.A., Ramsey, C.B., Crockett, K.L. & L.C. Hoover. (2001). Consumer thresholds for establishing the value

of beef tenderness. Journal of Animal Science 79: 3062-3068.

4. Morgan, J.B., Savell, J.W., Hale, D.S., Miller, R.K., Griffin, D.B., Cross, H.R. & Shackelford, S.D. (1991). National beef tenderness survey. Journal of Animal Science 69:3274-3283.
5. Destefanis, G., Brugiapaglia, A., Barge, M.T. & Dal Molin, E. (2008). Relationship between beef consumer tenderness perception and Warner-Bratzler shear force. Meat Science 78:153-156.
6. Koohmaraie, M., Kent, M.P., Shackelford, S.D., Veseith, E. & Wheeler, T.L. (2002). Meat tenderness and muscle growth: is there any relationship? Meat Science 62: 345-352.
7. Paterson, B.C. & Parrish, Jr, F.C. (1986). A sensory panel and chemical analysis of certain beef chuck muscles. Journal of Food Science 51: 879-896.
8. Koohmaraie, M. (1994). Muscle proteinases and meat aging. Meat Science 36:93-104.
9. Duckett, S.K., Snowder, G.D. & Cockett, N.E. (2000). Effect of the callipyge gene on muscle growth, calpastatin activity, and tenderness of three muscles across the growth curve. Journal of Animal Science 78:2836-2841.
10. Boles, J.A. Boss, D.L., Neary, K.I., Davis, K.C. & Tess, M.W. (2009). Growth implants reduced tenderness of steaks from steers and heifers with different genetic potentials for growth and marbling. Journal of Animal Science 87: 269-274.
11. Allingham, P.G., Harper, G.S. & Hunter, R.A. (1999). Effect of growth path on the tenderness of the semitendinosus muscle of Brahman-cross steers. Meat Science 48: 201-208.
12. Loken, B.A., Maddock, R.J., Stamm, M.M., Schauer, C.S., Rush, I., Quinn, S. & Lardy, G.P. (2009). Growing rate of gain on subsequent feedlot performance, meat, and carcass quality of beef steers. Journal of Animal Science 87: 3791-3797.
13. Calkins, C.R., Seideman, S.C. & Crouse, J.D. (1987). Relationships between rate of growth, catheptic enzymes, and meat palatability in young bulls. Journal of Animal Science 64:201-208.
14. Perry, D. & Thompson, J.M. (2005). The effect of growth rate during backgrounding and finishing on meat quality traits in beef cattle. Meat Science 69: 691-702.
15. Aberle, E.D., Reeves, E.S., Judge, M.D., Hunsley, R.E. & Perry, T.W. (1981). Palatability and muscle characteristics of cattle with controlled weight gain: Time on a high energy diet. Journal of Animal Science 52:757-763.
16. Fishell, V.K., Aberle, E.D., Judge, M.D. & Perry, T.W. (1985). Palatability and muscle properties of beef as influenced by preslaughter growth rate. Journal of Animal Science 61: 151-157.
17. Thomson, B.C., Muir, P.D. & Dobbie, P.M. (1991). Effect of growth path and breed on the calpain system in steers finished in a feedlot. Journal of Agricultural Science 133: 309-315.
18. NAMP (1988). The Meat Buyer's Guide. Virginia: National Association of Meat Purveyors.
19. Camfield, P.K., Brown, Jr. A.H., Johnson, Z.B., Brown, C.J., Lewis, P.K. & Rakes, L.Y. (1999). Effects of growth type on carcass traits of pasture-or feedlot-developed steers. Journal of Animal Science 77:2437-2443.
20. Smith, G.C., Culp, G.R. & Carpenter, L.Z. (1978). Postmortem aging of beef carcasses. Journal of Food Science 43:823-826.
21. Koohmaraie, M. (1996). Biochemical factors regulating the toughening and tenderization processes of meat. Meat Science 43: S193-S201.