Relationship of Myofibrillar Fragmentation Index to Warner-Bratzler Shear Force and Palatability Tenderness of *Longissimus Lumborum* and *Semitendinosus* Steaks

L.L. Prill, K.J. Phelps, J.M. Gonzalez, T.A. Houser, E.A.E. Boyle, and T.G. O'Quinn

Introduction

In the beef industry, tenderness, juiciness, and flavor are associated with beef palatability and overall eating experience (Smith and Carpenter, 1974). The odds of overall palatability failing when tenderness is acceptable is 10%, whereas the odds of overall palatability failing when tenderness is unacceptable is 69% (O'Quinn et al., 2016). The industry always strives to improve beef quality and palatability; thus, it is important to study tenderness in order to improve consumer satisfaction. Myofibrillar fragmentation index is a measure of tenderness that has previously been associated with sensory tenderness ratings (Olson et al., 1977). However, to our knowledge, little research has evaluated myofibrillar fragmentation differences within and between muscles. Therefore, the objective of this study was to determine the correlation between the myofibrillar fragmentation index, Warner-Bratzler shear force, and sensory traits of strip loins (*longissimus lumborum*) and the eye of round (*semitendinosus*) steaks.

Experimental Procedures

Forty beef strip loins (Institutional Meat Purchase Specifications #180) and 40 eye of rounds (Institutional Meat Purchase Specifications #171C) were collected from a Midwest beef processor and transported to the Kansas State University Meats Laboratory, Manhattan, KS. Sub-primals were divided into anatomical location (anterior, medial, and posterior for *longissiumus lumborum*; proximal and distal for *semitendinosus*) and cut into three 1-in thick steaks and aged 14 days. Within location, steaks were randomly assigned to Warner-Bratzler shear force, trained sensory panel evaluation, or myofibrillar fragmentation index analysis. Steaks used for Warner-Bratzler shear force and the trained sensory panel review were cooked to an internal temperature of 160°F on electric clamshell grills (Cuisinart Griddler Deluxe, Cuisinart, East Windsor, NJ). Steaks used for Warner-Bratzler shear force were chilled overnight at 40°F, and six 0.4-in cores were removed parallel to the orientation of the muscle fiber and sheared once perpendicular to the muscle fiber orientation through the center using an Instron testing machine (Model 5569, Instron Corp., Norwood, MA) with a Warner-Bratzler shear head. Sensory panel steaks were cut into 0.5 × 0.5 × 1-in cubes

and immediately served to sensory panelists trained following American Meat Science Association guidelines for sensory evaluation (2016). Myofibrillar fragmentation index was determined using procedures described by Culler et al. (1978). Data were analyzed as a completely randomized design with muscle as the fixed effect. Sub-primal location data were analyzed independent of muscle and as a completely randomized design with anatomical location as the fixed effect.

Results and Discussion

When comparing muscles, there were muscle differences (P<0.05) for all variables measured as shown in Table 1 except for off-flavor intensity. Steaks from *longissimus lumborum* had lower (P<0.05)Warner-Bratzler shear force, sensory panel connective tissue amount, and myofibrillar fragmentation index values than *semitendinosus* steaks. Additionally, *longissimus lumborum* steaks had higher (P<0.05) myofibrillar tenderness and overall tenderness sensory panel scores. There were location effects (P<0.05) for sensory and Warner-Bratzler shear force values of both muscles. Warner-Bratzler shear force values of all three locations within the *longissimus lumborum* were different (P<0.05) from one another (Table 2). Panelists rated anterior steaks higher (P<0.05) for myofibrillar and overall tenderness than middle and posterior steaks, which were not different (P>0.05) from each other. Panelists detected less (P <0.05) connective tissue in anterior steaks when compared to middle and posterior steaks, which were not different (P>0.05) from each other. In the *semitendinosus*, proximal steaks had higher (P<0.05) Warner-Bratzler shear force values and sensory connective tissue amounts than distal steaks (Table 3). Proximal steaks had less (P<0.05) myofibrillar and overall tenderness than distal steaks. Within each sub-primal, anatomical location had no effect (P>0.05) on myofibrillar fragmentation index value. Myofibrillar fragmentation index was correlated (P<0.05) to myofibrillar tenderness (r=-0.18), connective tissue (r=0.11), and overall tenderness (r=-0.15); however, myofibrillar fragmentation index was not correlated (P=0.056) to Warner-Bratzler shear force.

Implications

In *longissimus lumborum* and the *semitendinosus*, myofibrillar fragmentation index was not dependent upon anatomical location. Moreover, the correlation between myofibrillar fragmentation index, Warner-Bratzler shear force, and sensory measures of tenderness were weak, indicating myofibrillar fragmentation index was not a reliable indicator of beef tenderness for these muscles.

References

American Meat Science Association. 2016. Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of meat. Second edition, version 1.02. American Meat Science Association, Champaign, IL.

Smith, G. C., and Z. L. Carpenter. 1974. Eating quality of animal products and their fat content. Changing the fat content and composition of animal products. p 124-137. National Academy Press, Washington, D.C.

O'Quinn, T. G. (2016). Evaluation of the contribution of tenderness, juiciness, and flavor to the overall consumer beef eating experience. The Angus Foundation, St. Joseph, MO.

Olson, D. G. and Parrish, F. C. (1977). Relationship of myofibril fragmentation index to measures of beefsteak tenderness. Journal of Food Science, 42: 506–509.

Table 1. Effect of the *longissimus lumborum* (strip loin) and *semitendinosus* (eye of round) muscles on myofibrillar fragmentation index, Warner-Bratzler shear force, and sensory characteristics

| | Muscle | | | |
| | *Longissimus lumborum* | *Semitendinosus* | Standard error | P-value |
Item				
Myofibrillar fragmentation index	45.71[b]	65.13[a]	8.02	0.03
Warner-Bratzler shear force, lb	7.52[b]	9.92[a]	0.07	< 0.01
Sensory attribute[1]				
Initial juiciness	60.14[a]	45.98[b]	1.00	< 0.01
Sustained juiciness	46.58[a]	32.71[b]	1.16	< 0.01
Myofibrillar tenderness	73.71[a]	44.17[b]	1.31	< 0.01
Connective tissue amount	9.13[b]	28.83[a]	1.09	< 0.01
Overall tenderness	70.72[a]	35.90[b]	1.45	< 0.01
Beef flavor intensity	36.91[a]	33.10[b]	0.59	< 0.01
Off-flavor intensity	1.04	1.33	0.22	0.27

[a,b]Within a row, means without a common superscript differ (P<0.05).

[1]0 = extremely dry, extremely dry, extremely tough, none, extremely tough, extremely unbeef-like, and extremely bland; 100 = extremely juicy, extremely juicy, extremely tender, abundant, extremely tender, extremely beef-like, and extremely intense.

Table 2. Effect of steak location within the strip loin (*longissimus lumborum*) on myofibrillar fragmentation index and Warner-Bratzler shear force and sensory characteristics

Item	Location			Standard error	P-value
	Anterior	Middle	Posterior		
Myofibrillar fragmentation index	44.20	45.95	46.99	9.61	0.98
Warner-Bratzler shear force, lb	7.03[c]	7.54[b]	8.00[a]	0.08	< 0.01
Sensory attribute[1]					
Initial juiciness	59.99	61.92	58.51	1.27	0.09
Sustained juiciness	45.85	48.78	45.11	1.49	0.09
Myofibrillar tenderness	76.84[a]	72.32[b]	71.86[b]	1.37	0.01
Connective tissue amount	7.28[a]	9.81[b]	10.31[b]	0.78	0.01
Overall tenderness	74.29[a]	69.31[b]	68.56[b]	1.55	0.01
Beef-flavor intensity	35.16[a,c]	38.46[b]	37.11[b,c]	0.86	0.02
Off-flavor intensity	0.68	1.14	1.30	0.28	0.26

[a,b,c]Within a row, means without a common superscript differ (P<0.05).

[1]0 = extremely dry, extremely dry, extremely tough, none, extremely tough, extremely unbeef-like, extremely bland, and extremely bland; 100 = extremely juicy, extremely juicy, extremely tender, abundant, extremely tender, extremely beef-like, extremely intense, and extremely intense.

Table 3. Effect of steak location within the eye of round (*semitendinosus*) on myofibrillar fragmentation index and Warner-Bratzler shear force and sensory characteristics

Item	Location		Standard error	P-value
	Proximal	Distal		
Myofibrillar fragmentation index	66.77	63.49	11.79	0.78
Warner-Bratzler shear force, lb	10.69[a]	9.17[b]	0.09	< 0.01
Sensory attribute[1]				
Initial juiciness	42.79[b]	49.16[a]	1.29	< 0.01
Sustained juiciness	29.53[b]	35.90[a]	1.41	0.01
Myofibrillar tenderness	34.81[b]	53.54[a]	1.63	< 0.01
Connective tissue amount	37.20[b]	20.45[a]	1.64	< 0.01
Overall tenderness	24.95[b]	46.85[a]	1.70	< 0.01
Beef flavor intensity	32.54	33.65	0.69	0.26
Off-flavor intensity	1.04	1.62	0.34	0.24

[a,b]Within a row, means without a common superscript differ (P<0.05).

[1]0 = extremely dry, extremely dry, extremely tough, none, extremely tough, extremely unbeef-like, extremely bland, and extremely bland; 100 = extremely juicy, extremely juicy, extremely tender, abundant, extremely tender, extremely beef-like, extremely intense, and extremely intense.