EFFECT OF FREEZING THE BEEF *LONGISSIMUS* MUSCLE ON WARNER-BRATZLER SHEAR FORCE

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Summary

Seventy-two ribeye rolls (IMPS 112) were used to compare Warner-Bratzler shear force (WBSF) from fresh steaks and previously frozen steaks. Ribeye rolls were aged (32ºF) in vacuum-packaged bags for 14 days postmortem and fabricated into 1-inch thick *longissimus* muscle (ribeye) steaks. Steaks from each ribeye roll were either cooked fresh (158ºF) or stored at –20ºF before they were thawed and cooked for WBSF determination. Sensory panel determinations were also conducted on steaks stored frozen before cooking. Previously frozen steaks had lesser WBSF values (were more tender) than fresh (not previously frozen) steaks. Sensory panel attributes of myofibrillar tenderness, connective tissue amount, and overall tenderness were negatively correlated with WBSF for both fresh (r = –0.54, –0.53, and –0.58) and frozen (r = –0.63, –0.56, and –0.62) steaks, respectively. The WBSF of fresh steaks was also correlated (r = 0.48) with the WBSF of frozen steaks.

Introduction

A commonly accepted measurement of tenderness is Warner-Bratzler shear force (WBSF). It is a common protocol in research to freeze steaks before further sensory panel and/or WBSF determinations are performed. Freezing allows for flexibility in scheduling trained panels, handling of very large sample numbers and replications, and better control of product. Another common protocol for WBSF is to conduct analysis on fresh (not previously frozen) steaks. Previous work has shown that WBSF of fresh steaks may be greater (less tender) than WBSF values of previously frozen steaks. Therefore, the objective of this study was to compare fresh aged steaks to steaks that are aged and frozen before storage.

Experimental Procedures

Seventy-two ribeye rolls (IMPS 112) obtained from a commercial packing facility were stored at 32 ± 2ºF for 14 days postmortem. Ribeye rolls were faced and fabricated into three 1-inch thick *longissimus* muscle steaks, starting at the posterior end. One steak from each ribeye roll was randomly assigned to fresh (non-frozen) WBSF, frozen WBSF, and sensory panel. Steaks assigned to fresh WBSF were immediately cooked after the 14-day aging period. All other steaks were vacuum packaged and stored at –20ºF until analysis. Frozen WBSF steaks were thawed for 24 hours at 37ºF. All fresh and frozen steaks were cooked to an internal temperature of 158ºF in a Blodgett dual-air-flow convection gas oven. Steak temperature was monitored by using a thermocouple attached to a Doric mini trend. Steaks for WBSF were then stored overnight at 37ºF. After storage, eight 0.5-inch diameter cores were taken parallel to muscle fibers and sheared perpendicular to muscle fibers by a Universal Instron with a WBSF attachment.

Sensory-panel steaks were thawed and cooked by using the same procedures as for the WBSF steaks. Cooked steaks were cut into 0.5- × 0.5-inch cubes and placed in pre-heated double boilers. Sensory panels were conducted in individual booths with a mixture of red and green lighting. Duplicate samples were presented to a minimum of six trained panelists in a random order. Samples were evaluated for six sensory attributes according to an eight-point numerical scale and were scored to the nearest 0.5. Traits assessed were: myofibrillar tenderness (1 = extremely tough, 8 = extremely tender), juiciness (1 = extremely dry, 8 = extremely juicy), beef-flavor intensity (1 = extremely bland, 8 = extremely intense), connective-tissue amount (1 = abundant, 8 = none), overall tenderness (1 = extremely tough, 8 = extremely tender), and off-flavor intensity (1 = abundant, 8 = none).

All data were analyzed as a randomized complete block design with ribs serving as the block. Means were separated by the least significant differences procedure in SAS.

Results and Discussion

Previously frozen steaks had lesser ($P<0.05$, standard error = 0.17) WBSF values than fresh steaks (Table 1). The improved tenderness that occurred during freezing may be attributed to ice crystal formation causing muscle fibers to rupture, connective tissue to extend, and/or some proteolysis. All steaks were evaluated as slightly tender (score of 5) or better by the sensory panel. Sensory-panel scores for tenderness attributes of myofibrillar tenderness, connective tissue amount, and overall tenderness were negatively correlated with WBSF for both fresh and frozen steaks (Table 2). Fresh WBSF values were correlated ($r = 0.48$) with those from previously frozen steaks, but both were more closely correlated with sensory panel tenderness. Steaks that were previously frozen seemed to have similar, to slightly greater, correlations for myofibrillar tenderness (–0.63 vs. –0.54), connective tissue (–0.56 vs. –0.53), and overall tenderness (–0.62 vs. –0.58) compared with fresh steaks, respectively. The regression for sensory-panel scores for overall tenderness compared with WBSF of fresh and previously frozen steaks are presented in Figures 1 and 2. The relationship between overall sensory panel scores for tenderness and WBSF from fresh and previously frozen steaks seems similar, with a regression coefficient (R^2) of 0.36 and 0.39, respectively. However, WBSF means are greater for fresh steaks than for previously frozen steaks.

The relationship between sensory-panel scores for tenderness and WBSF from fresh steaks or frozen steaks seems similar. This indicates that using WBSF values from fresh or previously frozen steaks would be equally effective in predicting tenderness in beef *longissimus* steaks. Warner-Bratzler shear force values from fresh steaks, however, were significantly greater than WBSF values from frozen steaks. Therefore, researchers should be equally confident in WBSF results from fresh or previously frozen steaks when determining treatment differences in tenderness, but need to be aware that overall means may differ because of storage procedures.

Table 1. Descriptive Statistics for Warner-Bratzler Shear Force (WBSF) and Sensory Panel Evaluations of *Longissimus* Muscle Steaks

Item	Mean	SD[a]	Minimum	Maximum
WBSF (lbs)				
Fresh[b]	8.7	2.00	4.7	18.4
Frozen[c]	8.1	2.08	3.7	17.6
Sensory Panel[d]				
Myofibrillar Tenderness	5.7	0.36	5.2	6.3
Connective Tissue Amount	7.0	0.30	6.1	7.5
Overall Tenderness	6.0	0.41	5.1	7.1
Juiciness	5.8	0.29	5.2	6.6
Flavor	5.9	0.21	5.3	6.4

[a]Standard deviation.
[b]Steaks were cooked at 14 days postmortem.
[c]Steaks were frozen at 14 days postmortem.
[d]Sensory-panel scores were evaluated on an eight-point scale; (myofibrillar and overall tenderness 1 = extremely tough, 8 = extremely tender; connective tissue 1 = abundant, 8 = none; juiciness 1 = extremely dry, 8 = extremely juicy; flavor, 1 = abundant, 8 = none).

Table 2. Correlations between Warner-Bratzler Shear Force (WBSF) and Sensory Panel Attributes

Item	Fresh WBSF[a]	Frozen WBSF[b]	MT[c]	CT[d]	OT[e]	Juiciness
Frozen WBSF[b]	0.48*					
Myofibrillar Tenderness	–0.54*	–0.63*				
Connective Tissue	–0.53*	–0.56*	0.68*			
Overall Tenderness	–0.58*	–0.62*	0.95*	0.79*		
Juiciness	–0.07	–0.19	0.43*	0.26*	0.43*	
Flavor Intensity	0.07	–0.06	0.15	0.10	0.13	0.46*

[a]Steaks cooked and sheared at 14 days postmortem.
[b]Steaks frozen at 14 days postmortem.
[c]Myofibrillar tenderness.
[d]Connective tissue amount.
[e]Overall tenderness.
*$P<0.05$.

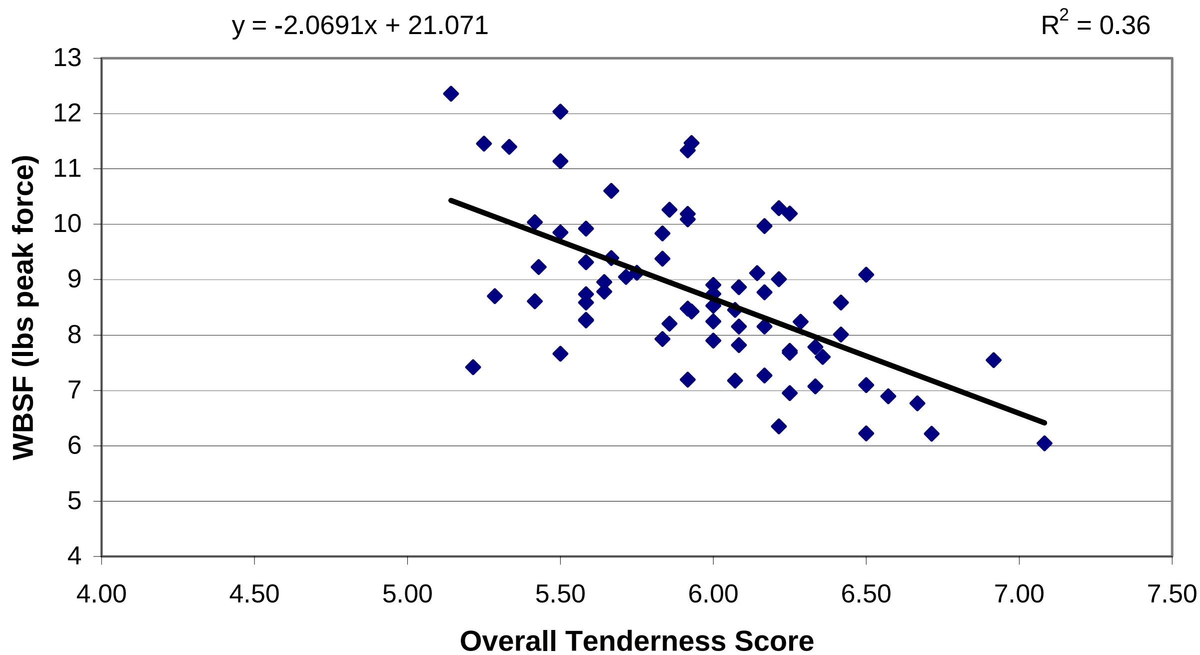

Figure 1. Warner-Bratzler Shear Force (WBSF) and Sensory-Panel Overall Tenderness Scores for Fresh *Longissimus* Muscle Steaks.

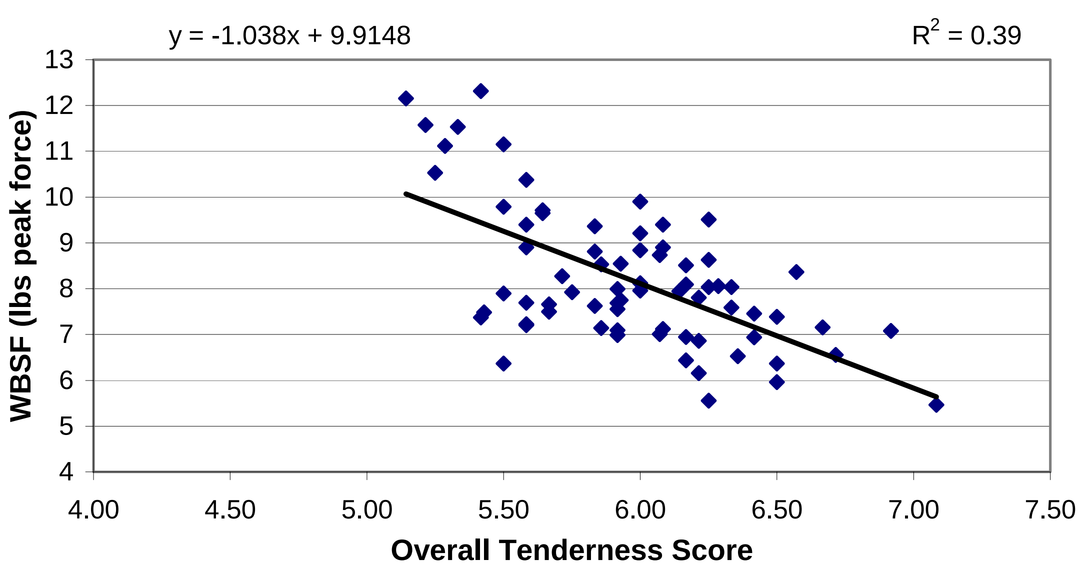

Figure 2. Warner-Bratzler Shear Force (WBSF) versus Sensory-Panel Overall Tenderness Scores for Frozen *Longissimus* Muscle Steaks.