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The Effects of Tumbler Volume on Roasted Beef Quality

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Tumbling is a mechanical method of extracting myofibrillar protein and dispersing marinade throughout meat. One-third free space in the tumbler appears to be essential in achieving optimum quality.

Summary

Semitendinosus beef muscles (n = 108) were used to determine optimum tumbler volume with regards to meat quality. Fill capacity of 2/3 meat had lower shear force values than capacities of 1/2 (P = 0.02) and 1/3 (P < 0.01). Texture profile analysis showed favorable results among treatments. Hardness was lower with 2/3 capacity than 1/2 (P = 0.02) and 1/3 (P = 0.06). Gumminess favored 2/3 capacity over 1/2 (P = 0.02). Springiness favored 1/2 capacity over 1/3 capacity (P < 0.01) and 2/3 capacity (P=0.04). Purge, absorption rate during tumbling, absorption rate after rest, cooking loss and yield had no effect between treatments.

Introduction

Value-added meats are becoming increasingly popular in today's marketplace. Low value and less desirable meats are improved in flavor, texture and consistency. This is accomplished with the use of marinades coupled with a mechanical action of massaging or tumbling. The ingredients of the marinades have well known effects. However, optimum times and volumes of the massaging method of tumbling are still unknown. The objective of this project was to study the effects of the fill/free space in the tumbler to optimize flavor, texture and consistency of muscle. This will allow processors to understand the implications on textural properties as associated with tumbler fill capacity.

Procedure

Semitendinosus, NAMP 171C Beef Round, Eye of Round were purchased from ConAgra Meat Company and were delivered to the University of Nebraska Loeffel Meat Lab. Muscles were removed from the bag and fat and heavy external connective tissue was trimmed. Each muscle then was cut to a weight of 5.6 lbs. Muscles were sorted into three different batches. The first batch contained eight muscles, a second batch contained 12 muscles and a third batch contained 16 muscles. The study was replicated three times. Total batch weights were taken. A marinade was formulated containing 0.9 lb salt, 1.4 lb phosphates and 85.7 lb of water. This allowed for 0.25% salt and 0.40% phosphates in the meat. Using a hand-held stitch pump, muscles were pumped with the marinade to 115% green weight evenly throughout the batch. An additional 10% of the fresh meat weight was added directly into the tumbler. It was determined that the capacity of the tumbler was 39.6 gallons. Using water displacement, the amount of meat needed for each treatment was determined. To reduce the amount of meat needed to fill the tumbler to a desired capacity, dummy bags, approximating the meat weight were filled with 1 liter of water were used to achieve desired fill capacity since the density of water and meat are similar. Twenty bags were added to 8 *semitendinosus* to allow for 1/3 fill, 32 bags were added to 12 *semitendinosus* for 1/2 fill and 44

(Continued on next page)

bags were added to 16 *semitendinosus* for 2/3 fill. Each batch was tumbled for 45 minutes under a vacuum of 0.8 torr. After tumbling was complete, the vacuum was released, the meat was removed, weighed to determine solution pickup and a sample of the exudate was taken for protein analysis. The muscles then were allowed to rest for 18 hours. A second sample of the exudate was taken prior to cooking.

The cooking process took place in a Alkar smokehouse (Alkar, Lodi, WI) with 180°F set point on the dry bulb and 155°F on the wet bulb. The muscles were cooked for approximately 7 hours to an internal temperature of 158°F. The meat was allowed to cool for 14 hours before analysis.

The muscles were removed and cut in half . A slice 1-inch thick was removed from the center, perpendicular to the muscle fibers for Warner-Bratzler Shear force analysis. An additional slice measuring 0.5 inches was removed for Texture Profile Analysis (TPA), a tenderness measure.

Table 2. Mean texture profile analysis.

	Fill Space		
Parameters	1/3	1/2	2/3
Hardness, N[a]	839.74[f]	846.75[f]	776.51[g]
Cohesiveness[b]	0.336	0.340	0.343
Gumminess, N[c]	282.94[fg]	289.52[f]	264.97[g]
Springiness, mm[d]	3.06[f]	2.90[g]	3.00[f]
Chewiness, N*mm[e]	863.54	838.77	794.84

[a]Peak force during first compression cycle; measured in Newtons.
[b]Ratio of the positive force area during the second compression to the first (A_2/A_1).
[c]Product of hardness times cohesiveness; measured in Newtons.
[d]Height of recovery during the time lapse from end of first compression to start of second compression.
[e]Product of gumminess times springiness.
[fg]Similar letters within row indicate significance (P > 0.10).

Table 3. Mean marination results.

	Fill Space		
Parameters	1/3	1/2	2/3
Purge, %[a]	2.67	3.08	5.40
Tumbling absorption, %[b]	12.60	11.07	11.24
Rest absorption, %[c]	9.61	7.63	5.24
Cooking loss, %[d]	34.71	34.28	31.75
Yield, %[e]	71.55	70.75	71.72

[a]Determined by weight after tumble minus weight after rest.
[b]Weight determined immediately after tumbling completed.
[c]Post-tumbling 18 hour rest absorption percentage.
[d]Cooked meat weight/ weight after rest.

Results

Significant differences in tenderness were determined by the Warner-Bratzler shear force test on treatment levels of 1/3, 1/2, and 2/3 tumbler capacity (Table 1). Tumbler capacity of 2/3 full had significantly lower shear force values than 1/2 (P = 0.02) and 1/3 (P< 0.01) capacities. Likewise, hardness (Table 2), using TPA, determined that 2/3 fill capacity had significantly lower values than 1/2 (P = 0.02) and 1/3 (P = 0.06). Hardness can be defined as the peak force during the first bite or compression of a sample. It was also determined in the TPA that 2/3 tumbler fill capacity had lower gumminess values than that of 1/2 fill (P = 0.02) but was not significantly lower than 1/3 fill capacity. Springiness can be defined as the time in which the sample recovers from the end of the first compression to the start of the second compression. It was determined that the tumbler fill of 1/2 had lower springiness than 1/3 fill (P = 0.01) and 2/3 fill (P = 0.04). The data also determined no significant differences among treatments for cohesiveness. Cohesiveness is described as ratio of positive force area during the second compression over that of the first (A_2/A_1). Chewiness, described as the product of gumminess times springiness also showed no significant differences. There were no significant interactions between the treatments in regards to percentage purge, rate of absorption immediately after tumbling, absorption after 18-hour rest, cooking loss and yield. Though the interactions were not significant, adjusted purge in the 2/3 fill capacity was 51% higher than that of 1/3 capacity. Also cooking losses tended to be less with 2/3 fill over both 1/3 and 1/2 fill.

Table 1. Warner-Bratzler mean shear force values.

	Force (lb)	
Fill space	Mean	SE[a]
1/3	8.93[b]	0.07
1/2	8.78[b]	0.05
2/3	8.43[c]	0.05

[a]Standard error of the means.
[b,c]Similar letters within column indicate significance (P > 0.05).

The implication of this data can help processors understand the effects of the fill capacity of tumblers and its results on the texture of beef. These data show that the majority of significant textural properties exists at 2/3 fill capacity; processors should target this in order to optimize product quality. The common practice of many processors is to make a batch and fill the capacity to what ever the batch is or to fill it with allows for best time management. The data shows that with management of tumbler fill, processors can make a more tender and consistent product.

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