Project Summary

Characterizing the Beef Heel Muscle under Different Cooking Conditions

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Background

The *gastrocnemius* is the primary muscle in beef heel and appears to be steak quality in tenderness. The beef heel muscle is associated with extension and relaxation of the hock and stifle joint. Chemical and tenderness profiling of this muscle has not been reported. Measurement of *gastrocnemius* tenderness in different cooking conditions and its chemical characterization will be beneficial to the meat industry. The heel muscle has both lateral and medial portions. The lateral portion consists of visible connective tissue but the medial portion is not densely meshed with connective tissue. Therefore, it seems obligatory to find if there are any differences in tenderness between the lateral and medial portions of the heel muscle under different cooking conditions.

The objectives of this research were to measure the shear force of the beef heel muscle (*gastrocnemius*) and characterize the uncooked *gastrocnemius* for pH, water holding capacity, composition and color.

Methodology

For heel muscle characterization and measurement of tenderness, 30 beef heel muscles were obtained. Out of 30 beef heel muscles, ten were cut for oven roasting, ten were cut for grilling and remaining ten were cut into steaks. Heel muscles for oven roasting and grilling were cut explicitly into lateral and medial portions, altogether consisting of 40 portions from 20 heels. The remaining ten heel muscles were cut into five steaks per heel. Lab analysis was done with ten uncooked steaks. All heel muscles were cut by first removing the *superficial digital flexor* muscle.

Color readings were taken by using a Hunter Lab Miniscan TM XE Plus Model 45/0-L (Hunter Associates Laboratory, Inc., Reston, VA) Colorimeter with a 2.54 cm sample port, illuminant D and 10° standard observer settings. Remaining steaks and cut heel portions were vacuum packed and kept frozen. Laboratory procedures were conducted for WHC (Water Holding Capacity), pH and composition. Steaks that were used for WHC previously were taken for pH analysis. A single steak was cut into two halves (lateral and medial), cubed and frozen in liquid nitrogen. After freezing, steaks were powdered for pH analysis. Fat, ash and moisture percentages of heel steaks were determined.

Heel muscles for oven roasting were taken out of the freezer and kept in a cooler 24 hours before roasting. Each portion was measured in every dimension and weighed before oven roasting. Then, portions were roasted at 69° C (156.2° F) with an oven temperature of 176°C (350° F), so as to maintain 71° C after removal from the oven. After roasting, samples were kept at room temperature and the dimensions and weights were measured. Samples were then kept in a cooler overnight, cut into four steaks and cored to measure shear force value by the WBSF (Warner-Bratzler Shear Force) method. Before coring each steak, pictures were taken to map the fiber direction of the lateral and medial portions of the heel muscle. Angles were measured by using a protractor on each steak.

A similar procedure was applied for grilling roasts and steaks. The internal temperature end point for grilled roasts and steaks was 69° C. Measurements and weights were taken before and after grilling. The following day, grilled roasts were cut into four slices which were cored and sheared by the WBSF method.

Findings

There were no differences between the shear force of lateral and medial areas of oven roasted heels, grilled steaks and grilled heel roasts (Table 1). Table 2 shows that the shear force value was different among the slices of oven roasted heels (P=0.04), where proximal-end slices were significantly different from distal-end slices. The same table illustrates that the shear force value was different for grilled steaks (P = 0.006) and similar for slices from grilled heel roasts (P = 0.73).

Tenderness differences in muscles may result from a combination of different factors such as intramuscular variation, type and solubility of collagen, muscle fiber type and post-mortem temperature decline (Reuter et al., 2002). The lateral portion of the heel muscle is less tender than the medial portion because of the presence of a mesh of connective tissue fibers entangled with the muscle bundles. As a result, the length of the lateral portion of the oven-roasted heel shortened during oven roasting.

Fiber angles from the medial portion of sampled heels were somewhat consistent among steaks but those measured from the lateral portions of heels were quite variable. The muscle fibers appear to be originating from each connective tissue lining in the lateral portion so there is no regular fibrous structure (Figure 1).

There were no differences in WHC, pH, ash, fat and moisture percentage in the heels among anatomical locations. The color was different among the sides as the lateral portion was less red in color compared with the medial portion.

Implications

Result of this research demonstrate that there is a significant difference between the tenderness of lateral and medial portions of the beef heel (*gastrocnemius*) with the medial being more tender than the lateral portion. The tenderness values obtained after shear force show that the medial portion of the heel muscle has steak-quality tenderness. Rather than grinding heel muscles as ground round, wholesalers can separate the medial portion and cut it into steaks to add value to the round.

Table 1. Shear force (kg) of the Lateral and Medial sides of the heel muscle

	Oven roasted heel		*P*- Value
	Area		
	Lateral	Medial	0.34
Shear force	4.30	4.13	
	Grilled steaks		
	Area		
	Lateral	Medial	0.41
Shear force	4.11	3.90	
	Grilled heel roast		
	Area		
	Lateral	Medial	0.98
Shear force	4.07	4.08	

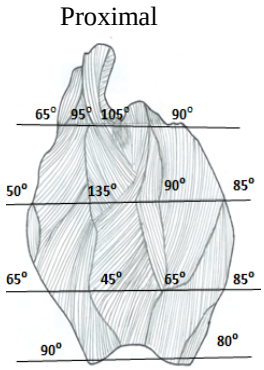
Areas were similar at the given *P* Values.

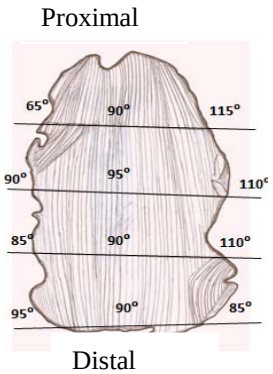
Table 2. Shear force (kg) of steaks from its proximal to distal end

	Slices from oven roasted heels				*P*- Value
	Steaks (from proximal to distal end)				
	1	2	3	4	0.04
Shear force	4.65[A]	4.19[AB]	4.10[B]	3.93[B]	
	Slices from grilled steaks				
	Steaks (from proximal to distal end)				
	1	2	3	4	0.006
Shear force	4.88[A]	3.73[B]	3.72[B]	3.70[B]	
	Slices from grilled heel roast				
	Steaks (from proximal to distal end)				
	1	2	3	-	0.73
Shear force	4.22[A]	4.15[A]	4.11[A]	-	

[A, B] Means in the same row having different superscripts are significant at their *P* Values.
There were only 3 steaks obtained from grilled heel roasts.

Figure 1. Lateral and medial portions of *gastrocnemius* showing fiber angles and anatomical positions





References

Reuter, B. J., D. M. Wulf, R. J. Maddock. 2002. Mapping intramuscular tenderness variation in four major muscles of the beef round. J. Animal Science. 80:2594-2599.

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