PS7.05 **Intramuscular tenderness mapping of small muscles in the beef round** 292.00

Lasika Senaratne (1) amilton@huskers.unl.edu;spitchie@unlnotes.unl.edu, C Calkins(1), A de Mello, Jr 1, S Pokharel 1 J Hinkle 1

(1)University of Nebraska, United States of America

***Abstract*—The intramuscular tenderness variation of m. pectineus (PT), m. sartorius (ST), m. gracilis (GL), m. vastus intermedius (VI), and m. vastus medialis (VM) was investigated. The PT, ST, VI, and VM muscles (n=10 each) were grilled as whole muscles whereas the GL was grilled after cutting in to anterior and posterior regions. Grilled muscles were cut into equal size sections perpendicular to the long axis from proximal to distal. Cores were prepared from each section and Warner-Bratzler shear force (WBSF) was measured. The overall mean WBSF values for PT, ST, VI, GL and VM were 3.76, 4.44, 4.78, 4.75, and 4.24 kg, respectively. The proximal ends of PT were significantly more tender than the distal end (*P* = 0.03) whereas the proximal end of ST were significantly tougher than the distal end (*P* = 0.04). There was no significant difference in tenderness between proximal and distal ends of VM; however, the most distal end of the muscle was less tender. Proximal and medial sides of VI were significantly tender when compared to distal and lateral sides, respectively. There was no significant intramuscular tenderness variation in GL. However, the most posterior section of the GL was tender compared to the rest (*P* = 0.02). These results provide information on intramuscular tenderness variation of small muscles in the round which could be use in a value added strategy for the round.**

L. S. Senaratne is with the University of Nebraska, Lincoln, NE 68583-0908 USA (e-mail: lasika_ss@yahoo.com).

C. R. Calkins is with the University of Nebraska, Lincoln, NE 68583-0908 USA (phone: 402-472-6314; fax: 402-472-6362; e-mail: Ccalkins1@unl.edu).

A. S. de Mello Jr., is with the University of Nebraska, Lincoln, NE 68583-0908 USA (e-mail: amilton@huskers.unl.edu).

S. Pokharel is with the University of Nebraska, Lincoln, NE 68583-0908 USA (e-mail: sirojpokharel@yahoo.com).

J. B. Hinkle is with the University of Nebraska, Lincoln, NE 68583-0908 USA (e-mail: jeremeyhinkle@yahoo.com).

***Index Terms*—Beef, Round Muscles, Tenderness.**

I. INTRODUCTION

ABOUT one fourth (about 22%) of the weight of a beef carcass is represented by the round. Most of large muscles of a beef carcass are located in the round and they are known to be the least tender muscles of the carcass. However, in the last few decades, the wholesale price of beef round has been significantly increasing [1]. Characterization of muscles in the beef round is necessary to evaluate value-added strategies. Tenderness is a major palatability trait that determines quality of meat [2]. Tenderness differences among major muscles of the beef round and chuck and their intramuscular tenderness variations have been well identified and reported [3][4][5]. This research was conducted to investigate the intramuscular tenderness variation of small muscles in the beef round, including m. pectineus (PT), m. sartorius (ST), m. gracilis (GL), m. vastus intermedius (VI), and m. vastus medialis (VM).

II. MATERIALS AND METHODS

Sample Collection

Ten of each of the PT, ST, GL, VI, and VM were purchased as USDA Choice boxed beef subprimals, aged for about 14 d from boxed date and frozen at -20°C after being vacuum-packaged. The PT, ST, and GL were fabricated from beef round top (IMPS #168; [6]) and VI, and VM were obtained from beef round, knuckle peeled (IMPS #167A; [6]). During fabrication, the anterior and distal directions of each muscle were appropriately tracked. Muscles were obtained from randomly selected left or right side of carcasses.

Determination of Warner-Bratzler Shear Force

Whole muscles were thawed at 4°C for 24 h. Anterior or distal directions of each muscle was tracked. The PT, ST, VI, and VM were grilled on a Hamilton Beach Indoor-Outdoor Grill (Model 31605A, Proctor-Silex Inc., Washington, NC), turning over once at 35°C, until they reached an internal temperature of 71°C. Prior to grilling, the GL was cut into anterior and posterior sides to have portions in equal thickness. Internal temperature was monitored using a type T thermocouple inserted into the geometric center of each muscle. Grilled muscles were cooled at 4°C for 24 h and then allowed to reach room temperature. After reaching room temperature, the PT, ST, and VM were cut in to proximal and distal zones and each distal and proximal end was cut into 2.54 cm thick portions perpendicular to the long axis of the muscle. Each anterior and posterior side of GL was divided into proximal and distal zones. Medial and lateral sides of VI were divided into sections from proximal to distal. From each section of PT, ST, VM, GL and VI muscles, cores with 1.27 cm diameter were removed parallel to the muscle fiber arrangement using a drill press. Cores were sheared on an Instron Universal Testing Machine (Model 55R1123, Canton, MA) with a Warner-Bratzler shear attachment. An average of the peak Warner-Bratzler shear force (WBSF) for each muscle pieces was calculated.

Statistical Analysis

Warner-Bratzler shear force values were analyzed by the using GLIMMIX procedure of SAS (version 9.1) with a model including zone (proximal to distal) of PT, ST and VT muscles [7]. The zonal difference (proximal vs distal) of each muscle was analyzed using CONTRAST statements. For GL and VI muscles, zone (distal to proximal), side (anterior and posterior) and their interactions were included in the model. The zone difference (proximal vs distal) and side difference (anterior vs posterior or medial vs lateral) of GL and VI muscles were analyzed using CONTRAST statements of SAS. Least square means were calculated for each section using the DIFF option of SAS. The mean separation was performed by LINES option of SAS at $P < 0.05$.

III. RESULTS AND DISCUSSION

The mean WBSF values of PT, ST, GL, VI, and VM were 3.76, 4.44, 4.75, 4.78, and 4.24 kg (standard deviations; 1.26, 1.86, 1.79, 2.80, and 1.76 kg, respectively). The WBSF values for tenderness levels were investigated and reported as follows: "tender"- <3.0 kg, "slightly tender/slightly tough" – 3.0 to 4.6 kg, and "tough" - >4.6 kg [8]. According to their classification, PT, SS, and VM were "slightly tender/slightly tough" and GL and VI were "tough" muscles.

There was no significant tenderness variation among sections of the PT (Fig. 1b). However, distal end of the PT muscle was significantly tougher than the proximal end (Table 1). The distal end of the PT is narrow and attaches to the femur. Lawrie mentioned that muscle fibers taper at the end and continue with non-contractile connective tissues in order to attach to the bones; therefore, muscles are tough at the distal end [9].

The tenderness of the ST significantly (P = 0.01) varied along the muscle (Fig. 1a). As shown in Table 1, the proximal end was tougher than the distal end of ST muscle (P = 0.04). This is more likely due to tapering of the muscle at the proximal end than distal end.

As shown in Table 1, the tenderness of the proximal and distal ends of the VM were similar (P = 0.12). However, the most distal region of the muscle was significantly tougher than the rest of the muscle (Fig. 1c).

There were no tenderness variations in the distal and proximal or anterior or posterior sections of the GL (Table 1). However, the most proximal section of the muscle is more tender than the rest (P = 0.002).

The tenderness of the VI muscle differed along the muscle (fig. 2b). The most lateral and distal region of the muscle was significantly tougher than the rest. The most tender region of the VI muscle was the most proximal and medial region (Fig. 2b). The distal region of the muscle was significantly tougher than the proximal region (Table 1). In addition, the medial side of the VI was significantly more tender than the lateral side (Table 1).

IV. CONCLUSION

The Warner-Bratzler shear force testing showed that m. pectineus, m. sartorious, and m. vastus medialis are slightly tender/slightly tough muscles whereas m. gracilis and m. vastus intermedius are tough muscles. However, there is a tenderness difference along the muscles. Therefore, m. pectineus, m. sartorius, m. vastus medialis and tender regions of m. gracilis and m. vastus intermedius can be marketed as single-muscle steaks.

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Table 1. Least square means of zones, sides, and regions of small muscles in beef round.

Muscle	Zone			Side			Region		
	Proximal	Distal	*P* value	Medial	Lateral	*P* value	Anterior	Posterior	*P* value
m. pectineus	3.56^b	3.96^a	0.03	NA	NA	NA	NA	NA	NA
m. sartorius	4.62^a	4.25^b	0.04	NA	NA	NA	NA	NA	NA
m. v. medialis	4.08	4.39	0.12	NA	NA	NA	NA	NA	NA
m. v. intermedius	4.28^b	5.29^a	<.0001	4.05^b	5.51^a	<.0001	NA	NA	NA
m. gracilis	4.66	4.84	0.08	NA	NA	NA	4.65	4.85	0.07

NA – not applicable

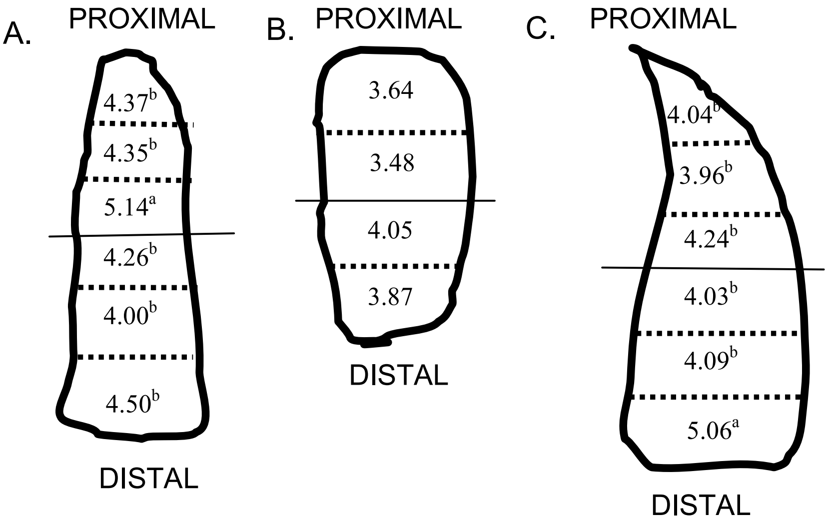

Fig 1. Least square means of each section of A. *m.sartorius* (ST), B. *m. pectineus* (PT), and C. *m. vastus medialis* (VM). *P* value of A. 0.01, B. 0.13, and 0.02. [a-b]Means in the same figure with different superscripts significantly differ ($P < 0.05$).

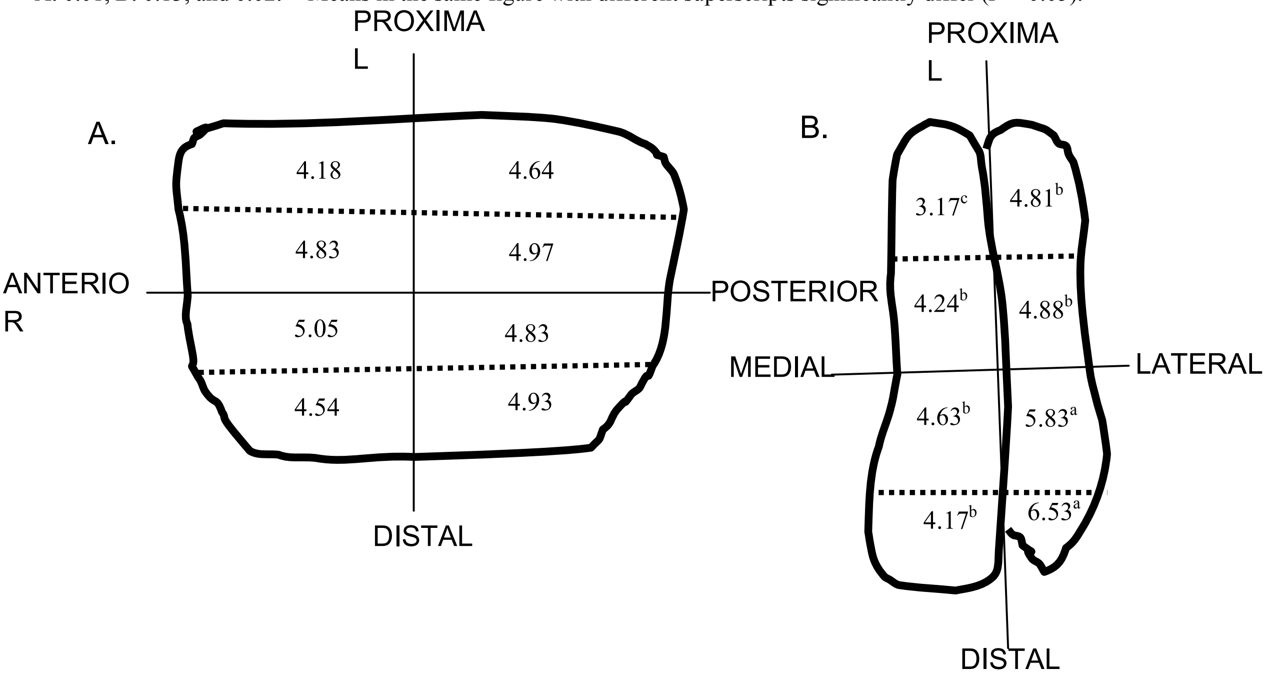

Fig 2. Least square means of each section of A. *m. gracilis* (GL), and B. *m. vastus intermediuss* (VI). *P* value of A. 0.08, and B. 0.04. [a-b]Means in the same figure with different superscripts significantly differ ($P < 0.05$).