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## Steak Location Within the Semitendinosus Muscle Impacts Metmyoglobin Accumulation on Steaks During Retail Display

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### Abstract

Beef color is a major attribute consumers utilize to make purchasing decisions. It is estimated poor color shelf-life of beef steaks costs the meat industry more than \$1 billion annually. Shelf-life color is influenced by a balance of two biochemical processes within steaks: metmyoglobin reducing ability and oxygen consumption. Steaks that exhibit a greater metmyoglobin reducing and a reduced oxygen consumption are typically characterized as more color stable. Characteristics of the muscle fiber or muscle cell are what determine the properties of a steak. Commonly, muscles with more oxidative fibers have an elevated oxygen consumption and reduced metmyoglobin reducing ability. The Semitendinosus muscle or eye of round possesses a divergent muscle fiber isoform distribution based on the location steaks are fabricated. The objective of this study was to examine effects of steak location on muscle fiber type distribution and metmyoglobin accumulation of Semitendinosus steaks.

### Keywords

color stability, muscle fiber type, Semitendinosus

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### Introduction

Beef color is a major attribute consumers utilize to make purchasing decisions. It is estimated poor color shelf-life of beef steaks costs the meat industry more than \$1 billion annually. Shelf-life color is influenced by a balance of two biochemical processes within steaks: metmyoglobin reducing ability and oxygen consumption. Steaks that exhibit a greater metmyoglobin reducing and a reduced oxygen consumption are typically characterized as more color stable. Characteristics of the muscle fiber or muscle cell are what determine the properties of a steak. Commonly, muscles with more oxidative fibers have an elevated oxygen consumption and reduced metmyoglobin reducing ability. The *Semitendinosus* muscle or eye of round possesses a divergent muscle fiber isoform distribution based on the location steaks are fabricated. The objective of this study was to examine effects of steak location on muscle fiber type distribution and metmyoglobin accumulation of *Semitendinosus* steaks.

Key words: color stability, muscle fiber type, *Semitendinosus*

### Experimental Procedures

Twenty *Semitendinosus* muscles (Institutional Meat Purchase Specifications 171C) purchased from a commercial abattoir were wet aged in a vacuum bag for 22 days at 35°F. Progressing from the proximal to distal end, each *Semitendinosus* was fabricated into twelve 1-in thick steaks. Steaks 1-4 were designated proximal, 5-8 were designated middle, and 9-12 were designated distal, with steaks 1, 6, and 12 utilized for fiber type analysis. Remaining steaks within each location were randomly assigned to 0, 4, or 9 days of simulated retail display. Steaks were placed on Styrofoam trays with an absorbent pad and overwrapped with poly-vinyl chloride film. Steaks were displayed in coffin-style retail cases set to 35°F under continuous fluorescent light. Day-0 and -4 steaks were utilized for metmyoglobin reducing ability and oxygen consumption analyses conducted according to procedures described by the American Meat Science Association. Day-9 steaks were subjected to daily objective surface discoloration measurements using a Hunter Lab Miniscan EZ and subjective steak surface discoloration analyses utilizing a visual panel of 8 panelists per day. On day 9 these

steaks were also subjected to metmyoglobin reducing ability and oxygen consumption analyses.

## Results and Discussion

To evaluate changes in discoloration of *Semitendinosus* steaks during display, metmyoglobin accumulation of *Semitendinosus* steaks was measured instrumentally over the course of 9-day simulated retail display. There was a location  $\times$  day interaction ( $P < 0.01$ ) for surface metmyoglobin percentage (Figure 1). On day 0 of display, proximal steaks had less surface metmyoglobin than the other locations ( $P < 0.01$ ), which were not different ( $P = 0.51$ ). On day 1, middle steaks had more metmyoglobin than the other locations ( $P < 0.04$ ), but distal steaks and proximal steaks did not differ ( $P = 0.70$ ). From day 2 to 6, middle steaks had more metmyoglobin than steaks from other locations ( $P < 0.01$ ), which did not differ ( $P > 0.17$ ). On day 7 of display, middle steaks tended to have more metmyoglobin than steaks from other locations ( $P < 0.09$ ), which did not differ ( $P = 0.65$ ). On day 8 and 9, middle steaks had more metmyoglobin than proximal steaks ( $P < 0.02$ ), and distal steaks did not differ from the two locations ( $P > 0.15$ ).

In addition to measuring metmyoglobin accumulation using an instrument, a visual panel was used to assess the amount of discoloration on *Semitendinosus* steaks. There was a location  $\times$  day interaction ( $P < 0.01$ ) for visual panel percent discoloration scores (Figure 2). No differences in panel percent discoloration scores were found between muscle locations on day 0 ( $P = 1.00$ ); however from day 1 to 5, middle steaks had more discoloration than proximal and distal steaks ( $P < 0.04$ ), which did not differ ( $P > 0.12$ ). From day 6 to 8, middle steaks had more discoloration than proximal steaks ( $P < 0.05$ ), and steaks from both locations did not differ from distal steaks ( $P > 0.16$ ). On day 9, proximal steaks had less discoloration than middle and distal steaks ( $P < 0.03$ ), which did not differ ( $P = 0.72$ ).

Accumulation of metmyoglobin on the surface of steaks is a balance of two biochemical processes within the steaks, metmyoglobin reducing ability and oxygen consumption. There was a location  $\times$  day interaction ( $P < 0.01$ ) for metmyoglobin reducing ability, (Figure 3). There was no location  $\times$  day interaction ( $P = 0.33$ ) for oxygen consumption indicating that only metmyoglobin reducing ability was driving metmyoglobin accumulation the surface of the *Semitendinosus* steaks. On day 0 and 4 of display, proximal and distal steaks had greater metmyoglobin reducing ability than middle steaks ( $P < 0.01$ ), but were not different ( $P = 0.33$ ) from one another. At day 9 of display, all locations possessed the same metmyoglobin reducing ability ( $P > 0.51$ ). At the end of display all locations also did not differ in surface metmyoglobin which corresponds to the reducing ability at the end of display.

Because muscle fiber type determines characteristics of a steak, the muscle fiber type distribution was examined across the locations of the *Semitendinosus* (Figure 4). Location affected percentage of all 3 fiber types ( $P < 0.01$ ). There were fewer type I fibers in proximal steaks than the other two locations ( $P < 0.01$ ), and middle steaks tended to have more type I fibers ( $P = 0.10$ ) than distal steaks. Proximal steaks had more ( $P < 0.01$ ) type IIA fibers than the middle location, and tended to have more ( $P = 0.07$ ) type IIA fibers than distal steaks. Steaks from proximal and middle locations did not differ ( $P = 0.72$ )

in type IIX fiber percentage, but did possess more type IIX fibers than the distal steaks ( $P < 0.01$ ).

### **Implications**

Throughout most of display, middle steaks accumulated more surface metmyoglobin than proximal and distal steaks, which was also detected by a visual panel. Steaks from the middle location possessed less metmyoglobin reducing ability compared to the other two locations on days 0 and 4 of display. Reduced metmyoglobin reducing ability and discoloration may be due to the middle location tending to possess less type IIA fibers. Based on these data, retailers selling steaks from the *Semitendinosus* need to be conscious that steaks from the middle of the muscle discolor faster. Retailers may want to display steaks from this location during times when the case is turning over more quickly.

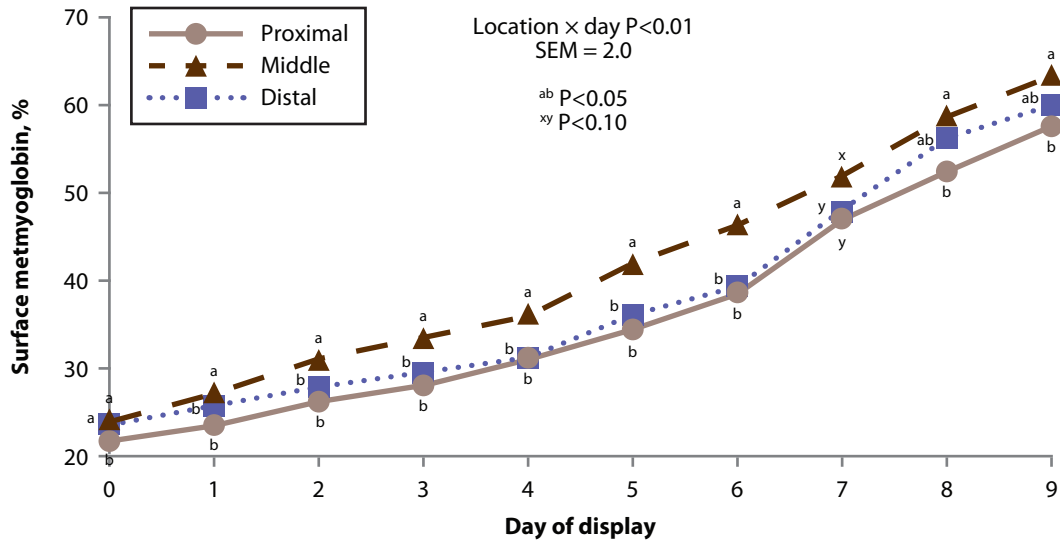


Figure 1. Surface metmyoglobin percentage of *Semitendinosus* steaks under simulated retail display captured using a Hunter Lab Miniscan.

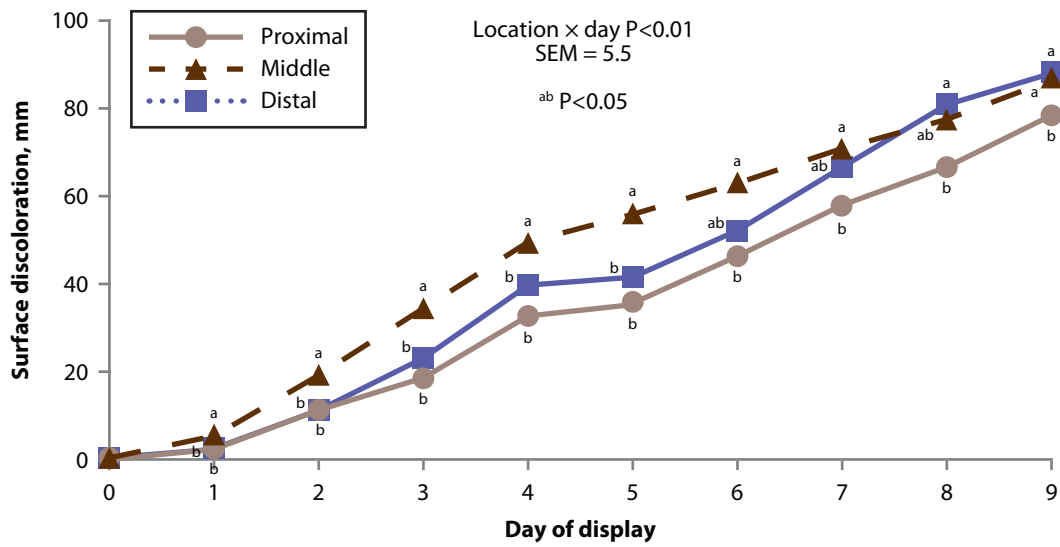


Figure 2. Surface discoloration percentages as observed by a visual panel; 0 mm = 0% discoloration; 100 mm = 100% discoloration.

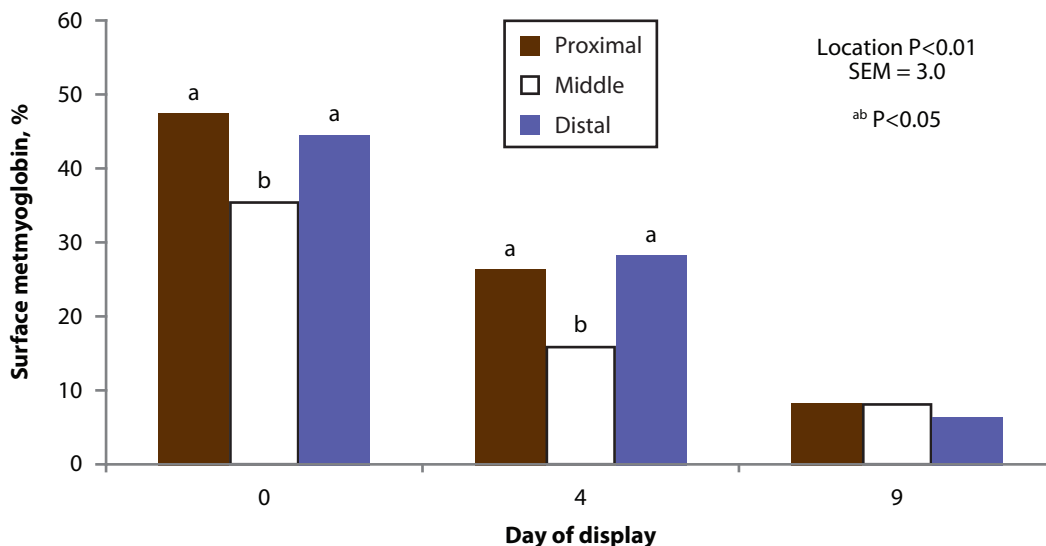


Figure 3. Metmyoglobin reducing ability of *Semitendinosus* steaks on day 0, 4 and 9 of simulated retail display.

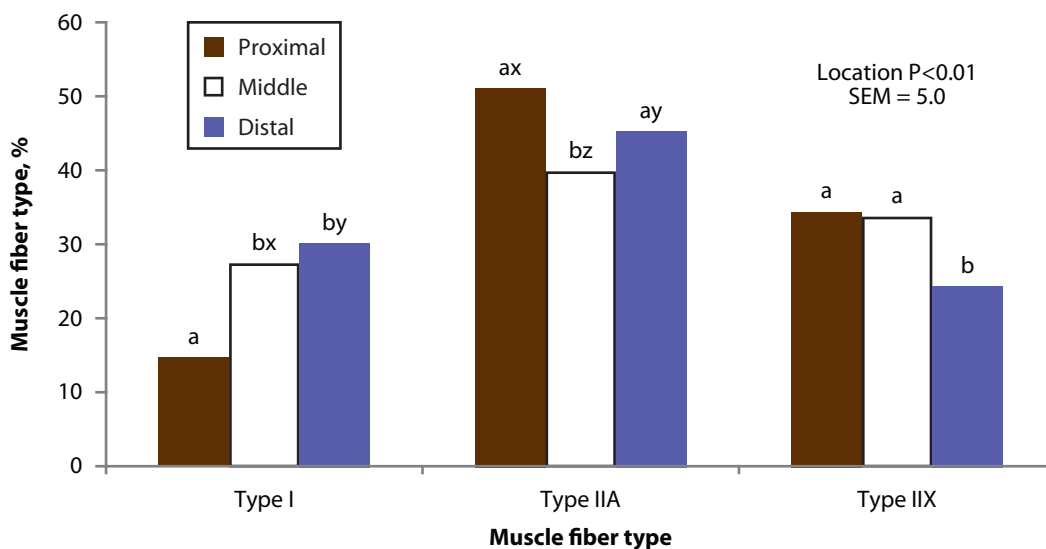


Figure 4. Muscle fiber type distribution of the proximal, middle, and distal locations within the *Semitendinosus*.

<sup>ab</sup>Within fiber type, means without common superscripts are different (P<0.05).

<sup>xy</sup>Within fiber type, means without common superscripts tend to be different (P<0.10).