

IMPROVING COLOR STABILITY OF BEEF TOP ROUND

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Summary

The beef inside round muscle, especially the deep portion, has poor color stability, a troublesome condition for the meat industry. We examined influences of pre-rigor temperature and pH decline on chemistry of the inside (deep) *semimembranosus* (ISM) and outside (surface) *semimembranosus* (OSM) in relation to initial color and stability. Cold-boned ISM had a slower chill rate; faster pH decline; more denatured protein; less metmyoglobin reducing ability, oxygen consumption, and water holding capacity; and a lighter, less stable color than the OSM. Cold-boned steaks were two-toned in color and discolored by day 3 of display. Hot-boned ISM and OSM chilled at the same rate, had similar pH declines, similar chemical characteristics, and acceptable color traits up to day 5 of display. Techniques that chill the entire beef SM faster produced a more uniform stable color, extended the color life of the ISM, and minimized rework and discounting.

(Key Words: Beef, *Semimembranosus*, Color Stability, Metmyoglobin, Reducing Activity.)

Introduction

The beef *semimembranosus* (SM) is a large, thick muscle of the inside round that extends from the carcass surface to the femur bone. Following slaughter, the inner (deep) portion of the muscle chills slower than the outer (surface) portion, causing differences in temperature/pH conditions. These influence the oxidation and reduction of the muscle pigment and myoglobin, thus affecting color stability. In case-ready packaging systems, the ISM discolors faster than the OSM.

Providing for more rapid chill of the deep portion (ISM) can slow pH decline and may influence muscle biochemistry in a way that provides more color stability. Industry recognizes the color difference within the SM muscle, but most color stability research on the muscle does not identify from what portion the samples were taken. We examined the effects of temperature and pH declines of the ISM and OSM on initial color, color uniformity and stability, and muscle pigment chemistry.

Experimental Procedures

Ten carcasses (A-maturity; quality grades high Select to low Choice; yield grades 2 to 3) were chosen randomly at a commercial slaughter plant. Five carcasses were electrically stimulated (continuous 48 volts for 30 seconds); the other five carcasses were not. One side of each carcass was assigned randomly to be hot boned at 30-90 min after stunning and the other half was left intact for chilling. The hot-boning technique involved cutting the SM loose from the outside round and tip muscles. The SM was left intact at the ventral surface of the hip-bone such that it hung away from the rest of the carcass, allowing chilled airflow to reach the inner surface. All 10 carcasses were chilled at 0°C and spray chilled 5 min every hour for 24 hours.

Temperature declines were monitored for 24 hours in the ISM and OSM and pH measurements were taken at 1, 3, 5, 7, 9, 11, and 24 hours postmortem. At 24 hours postmortem, inside rounds (NAMP #168) were boned, trimmed, and vacuum packaged and stored until 9 days postmortem. The SM was cut into six steaks, each an inch thick. Each

steak was assigned randomly for analyses, which were conducted on both the inside (inner 1/3) and outside (outer 1/3) portions. One steak was displayed for 6 days, with instrumental and visual color measurements taken daily. The remaining five steaks were used for analysis of shear force, metmyoglobin (Metmb) reducing ability, enzyme cofactors (NAD and NADH), myoglobin concentration, heme iron, nonheme iron, protein denaturation, lipid oxidation, oxygen consumption, water holding capacity, pH, and fiber type (succinic dehydrogenase activity).

Data were analyzed as a completely randomized split-split plot design where the SM muscle was the whole plot and storage was the whole-plot treatment. Steaks were the split-plots, and muscle location was the split-split plot. Proc Mixed procedure of SAS was used to determine treatment differences, and means were separated ($P < 0.05$) using least significant differences.

Results and Discussion

With traditional cold-boning methods, the ISM chilled slower ($P < 0.05$) than the OSM. However, hot boning allowed the ISM to chill faster ($P < 0.05$), resulting in temperature declines similar to cold-boned (CB) and hot-boned (HB) OSM (Fig. 1). Temperature decline affects postmortem glycolysis, and as a result, the pH decline of CB ISM was faster ($P < 0.05$) than for other treatments (Fig. 2). The ultimate pH at 24 hours postmortem was not affected by boning method. Therefore, with cold-boning and hot-boning, we successfully produced post-mortem conditions within the ISM and OSM that could result in chemical differences affecting color.

Color characteristics were similar between CB OSM and both HB portions, whereas CB ISM was distinctly different. On day 0 of display, CB ISM was visually a brighter ($P < 0.05$) cherry-red than the other treatments; however, the more desirable appearance was lost quickly (Fig. 3). No visual differences between treatments were found on day 1 of display, but CB ISM was the most discolored on day 2 through 5. Both HB portions remained visually accept-

able throughout 5 days of display. CB ISM had less ($P < 0.05$) oxymyoglobin, greater ($P < 0.05$) Metmb and lighter color (higher L^* values) than CB OSM or both HB portions on day 2-5 of display. Panelists classified CB steaks as moderately two-toned and HB steaks as uniformly colored during 5-day display. Faster temperature and slower pH declines of the ISM with hot boning within 30 to 90 min. following slaughter produced a more uniform, stable color.

Of the chemical characteristics measured, Metmb reducing ability, oxygen consumption, protein denaturation, and water holding capacity influenced the color stability of the ISM and OSM. Cold-boned ISM had less ($P < 0.05$) Metmb reducing ability than CB OSM and both HB portions. Metmb reducing ability of HB portions was higher ($P < 0.05$) on day 0 of display than for CB portions, with no differences on day 2 or 4. Oxygen consumption was greater in CB OSM than CB ISM, with no differences between HB portions. Proteins were more denatured in CB ISM than in CB OSM and both HB portions, which were not different. Low pH at high temperatures following slaughter apparently denatured proteins in CB ISM, whereas the faster chill of HB ISM reduced protein denaturation. Denatured proteins bind water poorly; therefore, CB ISM had greater ($P < 0.05$) expressible fluids than did CB OSM. Electrical stimulation had a minimal affect on chemical characteristics of the ISM and OSM.

No differences in myoglobin, heme iron, and nonheme iron and only small differences in pH, NAD, NADH, fiber type, and lipid oxidation were found between the ISM and OSM. Therefore, these characteristics were not related to color or color stability. Warner-Bratzler shear force values were not affected ($P > 0.05$) by electrical stimulation or boning method, meaning we were able to improve color stability of the ISM by hot boning, without altering tenderness.

Techniques that chill the entire beef SM faster, with or without electrical stimulation, should be used to produce uniform, stable color by conserving reducing ability and

lessening protein denaturation. Extending the color life of the SM can increase profit-

ability to the meat industry by lowering retail rework and discounting.

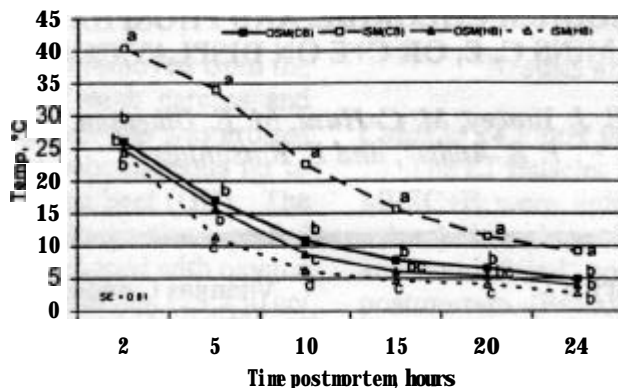


Figure 1. Means for Temperature Declines Postmortem of Outer and Inner Portions of the Inside Round Muscle (Semimembranosus = SM) That Were Intact or Hot Boned Before Chilling. Means at the times postmortem with a different letter are different ($P < 0.05$).

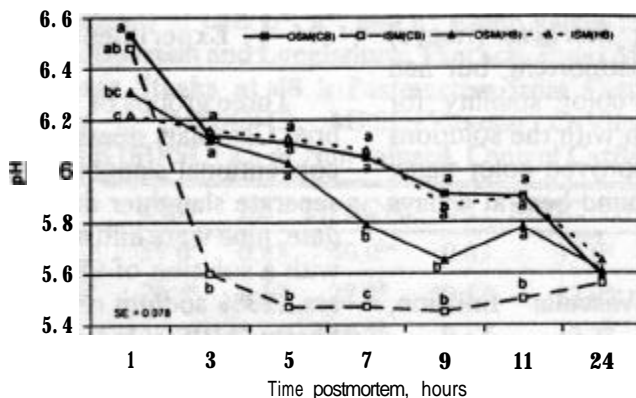


Figure 2. Means for pH Declines Postmortem of Outer and Inner Portions of the Inside Round Muscle (Semimembranosus = SM) That Were Intact or Hot Boned Before Chilling. Means at the times postmortem with a different letter are different ($P < 0.05$).

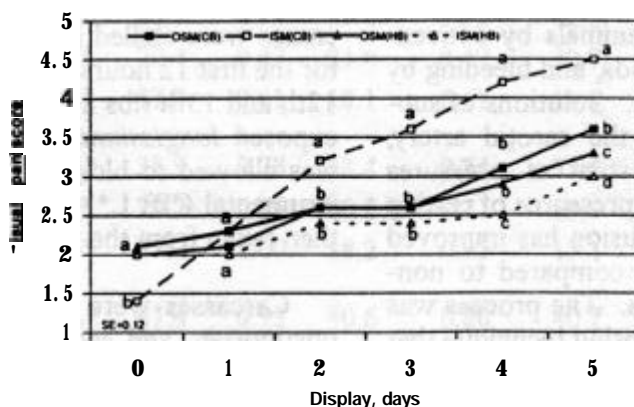


Figure 3. Means for Visual Color Scores of Inside Round Steaks (Semimembranosus = SM) During Retail Display (Lower Visual Scores Are Redder and Less Discolored; Scores at 3.5 or Higher Are Unacceptable Color). Half of the steaks were from carcasses with the SM muscle intact or hotboned during chilling. Means on a display day with a different letter are different ($P < 0.05$).