Project Title: Quality Attribute Characterization of Beef "Long Term" Muscles

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Background

The chuck and the round represent the largest percentage of the beef carcass, but their value has declined by approximately 30 percent over the last decade. Many of the smaller muscles of the chuck and the round, collectively termed "long term" muscles, have been characterized through muscle profiling studies funded by The Beef Checkoff. This research was done to create more valuable ways to fabricate and market cuts from the chuck and round.

The majority of research characterizing color stability in beef muscles has focused on high-value retail cuts, which have been packaged and examined for color and quality attributes during storage (e.g. *longissimus dorsi* or *psoas major*). There has been little research done on characterizing these attributes for the smaller "long term" muscles such as the *serratus ventralis* and *complexus* (chuck), or the *adductor* and *vastus lateralis* (round).

The goal of this project was to characterize chemical and physical quality attributes such as discoloration and sensory analysis of red, white and intermediate-fibered muscles from the chuck and round obtained from animals of various maturities and packaged aerobically or in modified atmosphere. Additionally, researchers sought to evaluate the color stability and palatability of moisture enhanced cuts.

Methodology

Thirty-six head of cattle, ages 18 months, 30 to 60 months and greater than 60 months, were divided into 12 groups. Age was verified originally by mouthing the cattle according to U.S. Department of Agriculture Animal Plant Health Inspection Service (USDA APHIS) procedures and was later confirmed using lean and bone scores from USDA quality grades to determine maturity. After harvest, carcasses were hung for 36 hours, fabricated and the following muscles were removed:

- *Infraspinatus* (chuck)
- *Serratus ventralis* (chuck)
- *Vastus lateralis* (round)
- *Adductor* (round)

On three of the slaughter days, the aerobic versus modified atmosphere packaging study was conducted and on the remaining three slaughter days, the moisture enhancement experiment was conducted. Two days postslaughter, muscles were each cut into eight steaks and randomly packaged aerobically in polyvinyl chloride film (PVC) or in a modified atmosphere packaging (MAP, 80 percent O2, 20 percent CO2). All packages were placed in a cooler (4°C) with fluorescent light to simulate retail storage conditions. PVC packages were stored for zero, two, four or six days. MAP packages were stored for three, seven, 11 or 14 days. On designated sampling days, samples were removed from storage and meat quality attributes examined. One half of the

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samples were used for raw analyses and the other half for cooked analyses. Steaks were examined for color percentage of surface metmyoglobin, lipid oxidation, pH, collagen and vitamin E

Steaks were cooked to an internal temperature of 71°C in a convection oven. Prior to cooking, all samples were weighed using a balance. After cooking, samples were weighed again and cook yield was calculated. Warner Bratzler shear force (WBSF) analyses were also performed. Cooked samples were also evaluated by a trained sensory panel for tenderness, juiciness, rancidity, off-flavor and overall acceptability using an eight-point scale.

Moisture enhanced steaks were injected with a brine solution to 8 percent above their initial weight using a belt injector. Muscles were allowed to rest overnight to maximize brine uptake and were analyzed for color, percentage of surface metmyoglobin, lipid oxidation, pH, collagen, and vitamin E. Cooked steaks were prepared using a convection oven and were analyzed for cook yield, texture analysis, and sensory evaluation by a trained panel.

Findings

Aerobic versus Anaerobic Packaging Characterization
In general, steaks that were packaged in PVC discolored at a faster rate than those stored in modified atmosphere packaging. Steaks from the *infraspinatus*, *serratus ventralis* and *vastus lateralis* increased in redness values until day three and then decreased for the remainder of the storage time. The researchers hypothesized that the increase in redness values (a*) was the result of continued oxygen saturation of beef packaged in modified atmosphere packaging.

Supporting trends were observed when the percentage of surface metmyoglobin was measured. Steaks from cattle of all ages had a general and *serratus ventralis* were packaged in PVC, steaks from all age groups rapidly developed a greater percentage of metmyoglobin within the first two days, but continued to gradually increase during the remaining storage time. The same trend was observed for *adductor* steaks from the 18 and 60-month age groups. These findings may also help explain the dramatic increase in a* values over the same time period as a reddish brown meat surface color is due to increased levels of metmyoglobin. *Infraspinatus* steaks from all age groups and *serratus ventralis* steaks from the 18 and 60-month age groups packaged in MAP had a significantly lower final percentage of surface metmyoglobin than those steaks packaged in PVC.

Tenderness of all muscles was evaluated using Warner Bratzler shear force measurements. Age had a significant effect on the tenderness of steaks stored in both PVC and MAP packages. Cattle in the 18-month age group produced steaks that were significantly more tender for *infraspinatus*, serratus ventralis, *vastus lateralis* and *adductor* muscles. *Infraspinatus* muscles were the most tender and *vastus lateralis* was the least tender.

The tenderness trends determined through Warner Bratzler shear force were not well reflected when steaks were evaluated by a trained sensory panel. Steaks from the *infraspinatus*, *vastus lateralis* and *adductor* from 60-month old cattle were judged to be the toughest. Panelists found that *serratus ventralis* steaks from 18-month old cattle were more tender than the other two age groups, yet had a difficult time distinguishing between 18 and 30-month old cattle for the other muscles. Although collagen generally plays a role in the toughness of beef, no muscle effects were noted for collagen levels in this experiment.

The trained sensory panel also evaluated juiciness and found that steaks from cattle in the 60-month old group produced *adductor* and *infraspinatus* steaks that were the least juicy across all treatments. For the *serratus ventralis*, 30 and 60-month old cattle produced the

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least juicy steaks and *vastus lateralis* steaks from the 18 and 60-month old group were the least juicy. The sensory panel also determined steaks from the *infraspinatus* and *serratus ventralis* to be significantly more juicy than steaks from the *adductor* and *vastus lateralis*.

Packaging type did not significantly influence cook yield. Lipid oxidation rates were significantly greater for steaks stored in modified atmosphere packaging than for those stored in PVC. Lipid oxidation rates were the greatest for the *vastus lateralis* and adductor, which are often termed "intermediate" and "white" muscles from the round. These results were unexpected as increased lipid levels in "red" muscles with higher myoglobin concentrations (e.g. *infraspinatus*) would be expected to have greater lipid oxidation.

Moisture Enhancement Characterization

The pH of enhanced steaks was higher than that of non-enhanced steaks. No significant effects of age or enhancement were noted when redness of infraspinatus, *serratus ventralis* and *adductor* steaks from cattle in 18, 30 and 60-month old age groups were measured using a* values. Redness values tended to decrease over the course of storage. Additionally, no effects of age or treatment were noted in measurements of surface metmyoglobin. Percentage of metmyoglobin did increase over time, however.

Both cattle age and brine enhancement had significant effects on the Warner Bratzler shear force tenderness values observed for steaks from the *infraspinatus*, serratus ventralis, *vastus lateralis* and adductor. The trained sensory panel evaluations for tenderness correlated well with the findings from the Warner Bratzler shear force evaluations.

Percentage cook yield was affected by the moisture enhancement treatment. Moisture enhancement improved cook yields for only the *serratus ventralis* from cattle in the 18-month age group. This agrees with previous research, which demonstrated that there is increased cooking losses for moisture enhanced meat products, simply because these products have more water to lose. Salt and phosphate ingredients in brines are meant to increase water holding capacity, however their effects may not be sufficient to retain 100 percent of the incorporated liquid and increased cook losses have been noted.

The trained sensory panel found the *serratus ventralis* to be the juiciest muscle overall. Moisture enhancement increased the juiciness of steaks from the *infraspinatus, serratus ventralis* and *adductor* from all age groups. Adductor and serratus lateralis steaks from cattle in the 18 and 30-month groups were significantly more juicy than steaks from the 60-month group.

Flavor attributes were measured objectively by evaluating lipid oxidation rates. In general steaks from *vastus lateralis* and *adductor* muscles had greater levels of lipid oxidation, however rates of oxidation increased at an expected rate over the course of the study. Steak rancidity was also measured using a trained sensory panel. There were no significant differences among the muscles.

The sensory panel also evaluated overall acceptability of samples and found the *infraspinatus* steaks to be the most acceptable muscle. Steaks from the 60-month old cattle were less acceptable than the other two age groups. Steaks enhanced with brine had greater overall acceptability scores than non-enhanced steaks.

The *infraspinatus* and *serratus ventralis* steaks performed best overall. They were the most tender, the juiciest and had a lesser extent of lipid oxidation. Addition of brine to *vastus lateralis* and *adductor* muscles appeared to increase the tenderness and juiciness of both

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of these muscles; however, sensory panelists did not find these cuts as acceptable as those from the chuck. Overall, brine enhancement was most beneficial to muscles from older cattle.

Implications

Results from this study indicate that the quality of steaks from older animals can be improved significantly with moisture enhancement. Reducing the variability in whole muscle cuts from older animals has the potential to create more valuable marketing opportunities for producers and reduces the chance that consumers will have an unsatisfactory eating experience.

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