Project Title: Color Stability, Fatty Acid Profile, and Shelf-Life of Ground Chuck and Round Muscles of Fed Beef Steers, Beef Cull Cows, and Dairy Cull Cows

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Background

The beef industry has many questions about the most efficient and economical use of cow meat in ground beef. This is because utilizing muscles of varying color stability at optimal levels will increase the ultimate color and shelf-life of ground beef, the largest single beef commodity. Round and chuck muscles differ in their color stability and understanding their interaction when mixed is essential to optimizing ground beef shelf-life containing cow and/or young steer or heifer beef. Demonstrating that certain cow muscles may be as functional as some muscles from young beef could have significant economic benefits for meat processors and ultimately lead to increased cull cow value.

This project was split into three experiments and the objectives for each experiment include:

Experiment 1

1. Compare the color stability of ground beef from muscles of varying color stability from fed steers and cows.
2. Determine the effect of age on color stability of cow meat.

Experiment 2

1. Evaluate interactions of ground muscles of different color stability on the overall color life during display of ground beef.

Experiment 3

1. Determine if cow type (beef vs. dairy) makes a difference in the color dynamics and stability of ground beef.

Methodology

Experiment 1
Six muscles, *semimembranosus*, *biceps femoris*, *semitendinosus*, *longissimus thoracis*, *triceps brachii* and *supraspinatus*, were isolated from cull cows (n=20 beef type) and A-maturity steers (n=20) at 5 days postmortem. Cull cows were separated into two groups, fed and non-fed, and were further segmented in to three age classes including young, mature and very mature. Fed cows and steers were fed the same diet for 60 days antemortem. Two, 114-gram ground beef patties were made from the center of each muscle and the remaining intact tissue from each muscle was vacuum packaged and frozen for use in Experiment 2. Beef patties were packaged on foam trays with oxygen permeable film overwrap and placed in a lighted retail display case for 5 days with packages rotated daily in the case. Samples were utilized for pH determination, fatty acid analysis and instrumental color evaluation (L^*, a^*, b^*).

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Experiment 2
The cow muscles evaluated in Experiment 1 were ranked according to color stability. The individual muscles exhibiting the highest, intermediate and lowest *a** values over the display period were chosen including the *longissimus thoracis* (high), *semimembranosus* (intermediate) and *triceps brachii* (low). Six ground beef formulations of varying color stability were used: 50% high, 50% intermediate; 50% high, 50% low; 50: intermediate, 50% low; 33.3% high, 33.3% intermediate, 33.3% low; 75% high, 25% low; and 25% high, 75% low. Each mixture was formulated at both 90% and 80% lean points creating a total of 12 treatment combinations. Beef 50's from A-maturity carcasses were used to achieve the desired lean point for each treatment and two patties (114 grams each) from each batch were made by hand.

Patties were packaged in deep, rigid plastic trays and covered with oxygen-barrier film in a high-oxygen modified atmosphere. Packages were stored in dark conditions for 5 days and then placed in a lighted retail display case for 5 days with packages rotated daily in the case. Instrumental color, pH and fatty acid evaluations were conducted as in *Experiment 1* along with visual panel color evaluation, thiobarbituric acid reactive substances (TBARS) analysis and metmyoglobin-reducing activity (MRA) analysis.

Experiment 3
Inside round from beef cows (n=4) and dairy cows (n=4) were obtained 5 days postmortem and were selected for use in *Experiment 3* based on the fact that *semimembranosus* was identified as a muscle with intermediate color stability in *Experiment 1*. The lean was blended to obtain three different lean-source combinations: 100% beef cow lean; 50% beef cow lean and 50% dairy cow lean; and 100% dairy cow lean. For each lean-source combination, the ground beef was formulated to both 90% and 80% lean points using beef 50's and cow 50's for a total of 12 treatment combinations. Package, storage and display followed methodology for Experiments 1 and 2. Analysis included pH, instrumental color, visual color evaluation, fatty acid analysis, TBARS and MRA.

Findings

Experiment 1
After 4 days of display, ground muscles from fed cows, and some ground muscles from non-fed cows, generally had more desirable color stability than ground muscles from steers. A likely reason is the interaction between pH, increased pigment concentration with animal age and myoglobin chemistry. There was no obvious relationship to the fatty acid profile other than the fact that a greater proportion of total fatty acid was found in ground semimembranosus and semitendinosus from cows than from steers. It is feasible that ground beef from fed cows, and certain muscles from non-fed cows, can be sued in ground beef without adverse color effects. Several of these muscles would be reasonably easy to collect and channel to ground beef operations.

Experiment 2
The trained visual color panel determined that the treatments of 50% high + 50% intermediate, 50% high + 50% low, and 75% high + 25% low at the 80/20 lean point had the most cherry red color. By day 4, all samples had visual color scores beyond the acceptability threshold, with the combinations of 75% high + 25% low and 50% high + 50% intermediate demonstrating the lowest visual color scores. Combinations containing 50% or more high color stability lean and less than 50% low color stability lean experienced only minor decreases in lightness (*L**) during the 4 day display period. Moreover, inclusion of low color stability muscles at greater than 25% had negative effects on the overall *a** value during display.

Differences in fatty acid profile between treatments were not significant in Experiment 2. TBARS values for Experiment 2 were very high at the onset of display. However, treatments

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of 50% high + 50% intermediate and 75% high + 25% low had the lowest TBARS values (low = favorable) at days 2 and 4 of display. In terms of MRA, the percentage of metmyoglobin reduced to deoxymyoglobin was the highest for samples comprised of 75% high + 25% low and 50% high + 50% intermediate color stability muscles as day 0 of display. This experiment demonstrated that certain muscles from cows can be viably used in blended ground beef operations. However, inclusion rate of low-stability muscles should not exceed 25% and high-stability muscles should comprise at least 50% of the blend.

Experiment 3
A trained color panel determined that 80/20 ground beef from beef cow inside rounds had a the lightest initial color score while the 90/10 combination of dairy cow inside round fattened with cow 50's had the darkest. However, the combination of dairy lean fattened with cow 50's yielded superior visual color score at day 4 of display. Treatments containing only beef cow lean discolored rapidly. Ground beef from beef cows tended to have higher *L** (lightness) values than ground beef from dairy cows. The lightest color at day 4 of display was fro ground beef sourced from beef cows and formulated with young beef fat. Ground dairy cow inside round, fattened with either form of 50's, had higher *a** (redness) values throughout display than ground beef inside round. By day 4, *a** values of ground dairy cow inside round were clearly superior to ground beef cow inside round. Using a*/b* ration as an indicator of discoloration, the inclusion of ground dairy cow had appreciable benefits to increasing ground beef color stability.

As expected, all lean combinations fattened with beef 50's and 80% lean had higher concentrations of stearic acid than all lean combinations fattened with cow 50's to 90%. For the beef-only ground beef, 80% lean samples had lower TBARS values than 90% lean samples. The dairy-only treatments fattened with cow 50's had the lowest day 4 TBARS values. In general, the fat source substantially increased the MRA of the ground beef blends, ground beef made with young beef trim had less MRA than did ground beef from dairy cows.

Ground dairy cow lean originating from muscles of intermediate color stability has a display color life equal to or better than ground beef cow lean of the same muscle type. Also, use of cow 50's as a fat source improved the color stability of ground beef.

Implications

In Experiment 1, fed cows had generally better color stability than non-fed cows, and for some muscles, the color stability of ground cow muscles did not differ from the color stability of ground cow muscles. Data from Experiment 2 indicated that when cow muscle color stability is known, combinations of high, intermediate and low color stability muscle can be mixed provided the inclusion rate of low stability muscle does not exceed 25%, and that high stability muscle comprises at least 50% of the blend. The results of Experiment 3 indicate that ground dairy cow lean originating from muscles of intermediate color stability has a display color life equal to or better than ground beef cow lean of the same muscle type and that use of cow 50's for a fat source improved the color stability of ground beef.

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