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**Abstract**
It is widely accepted that meat color is the most important influencer of consumers' meat purchasing decisions. Understanding how ground cow meat discolors is, and will continue to be, very important as a large influx of cull dairy cows in the U.S. meat supply is predicted. Optimal management and more timely marketing of cows should result in increased revenue for the beef industry. However, many valuable by-products from cows have been labeled as specified risk materials accompanied by a lost value. Thus, there is an unprecedented need to add value to cow meat. Research characterizing cow muscles and how to optimally use them for ground beef production could increase the value of cull cows and result in improved management and use of meat from cull cows. Our objectives were to evaluate the display color life of ground beef from different muscle combinations that vary in pre-established color stability values and determine if using beef or dairy cow meat affects color dynamics and stability of ground beef.

**Keywords**
Cattlemen's Day, 2008; Kansas Agricultural Experiment Station contribution; no. 08-212-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 995; Beef; Cattle; Meat color

# OPTIMIZING GROUND BEEF LEAN SOURCES TO MAXIMIZE DISPLAY COLOR LIFE[1]

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## Introduction

It is widely accepted that meat color is the most important influencer of consumers' meat purchasing decisions. Understanding how ground cow meat discolors is, and will continue to be, very important as a large influx of cull dairy cows in the U.S. meat supply is predicted. Optimal management and more timely marketing of cows should result in increased revenue for the beef industry. However, many valuable by-products from cows have been labeled as specified risk materials accompanied by a lost value. Thus, there is an unprecedented need to add value to cow meat. Research characterizing cow muscles and how to optimally use them for ground beef production could increase the value of cull cows and result in improved management and use of meat from cull cows.

Our objectives were to evaluate the display color life of ground beef from different muscle combinations that vary in preestablished color stability values and determine if using beef or dairy cow meat affects color dynamics and stability of ground beef.

## Experimental Procedures

**Sampling.** For the first objective, six ground beef combinations were formulated using three cow muscles of predetermined color stability: *M. longissimus thoracis* (high stability), *M. semimembranosus* (intermediate stability), and *M. triceps brachii* (low stability). While ground *M. supraspinatus* exhibited slightly poorer color stability than ground *M. triceps brachii*, sufficient product was not available for *M. supraspinatus* muscle due to its small size. The ground beef formulation combinations were: 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 muscles. Each mixture was formulated at both 90% and 80% lean points for a total of 12 treatment combinations. Beef trim, approximately 50% fat and 50% lean, from A-maturity carcasses was obtained 2 days postmortem and used to achieve the desired lean percentage for each treatment. Lean and fat were coarse-ground and then fine-ground. Two 0.25-lb patties from each batch were formed by hand using a mold.

To accomplish the second objective (beef cow vs. dairy cow ground beef), inside rounds from beef cows (n = 4) and dairy cows (n = 4) were obtained 5 days postmortem from a commercial abattoir. Inside round muscle (*M. semimembranosus*) was used because it was identified as an intermediate color stability muscle. All muscles were trimmed of visible

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fat. The lean was then 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 50% lean/50% fat young beef trim and also 50% lean/50% mature cow trim, for a total of 12 (3 blends x 2 lean points x 2 fat sources) treatment combinations.

**Packaging and Storage.** Ground beef patties were placed in rigid plastic trays and covered with oxygen-barrier film, and patties were packaged in high-oxygen (80% $O_2$, 20% $CO_2$) modified atmosphere packaging (MAP). Because measuring instrumental color in MAP requires opening a package, two extra packages of each treatment were made for day 0 and day 2 of display only, and those for use on day 4 were also evaluated by the visual panel. Packages were stored in dark conditions for 5 days at 34-36°F and then displayed under continuous fluorescent lighting for 4 days.

**Color Analyses.** Instrumental color (L*, a*, and b*) was measured using a HunterLab MiniScan™ at 0, 0.5, 1, 2, 3, and 4 days of display. Instrumental color was scanned in triplicate and averaged. Initial visual color was evaluated on an 8-point scale, and panelists were instructed to score patties to the nearest 0.5 visual color unit. The scale used for initial color was: 1 = bleached, pale red, 2 = slightly cherry red, 3 = moderately light cherry red, 4 = cherry red, 5 = slightly dark red, 6 = moderately dark red, 7 = dark red, and 8 = very dark red. Display visual color was scored for 5 days on an 8-point scale to the nearest 0.5 unit according to the following scale: 1 = very bright red or pinkish red, 2 = bright red or pinkish red, 3 = dull red or pinkish red, 4 = slightly dark red or pinkish red, 5 = reddish tan or pinkish tan, 6 = moderately dark red or reddish tan or moderately dark pinkish red or pinkish tan, 7 = tannish red or tannish pink, and 8 = tan to brown. Panelists considered a score of 5.5 to be borderline acceptable color.

## Results

There was a three-way interaction (treatment x lean point x day of display) for visual color and instrumental color. The a* (redness) instrumental color value has precedence of being a good indicator of color stability; a* values are reported in Tables 1 and 2. Visual score data is presented in Tables 3 and 4.

The combination of 75% high + 25% low (80/20 and 90/10 lean points) and 50% high + 50% intermediate (80/20 lean point) yielded the most desirable a* value by day 4 of display (Table 1). Combinations containing 50% or more low color stability muscles had the least desirable a* values by day 4 of display. Thus, the inclusion of low color stability muscles at greater than 25% had negative effects on the overall a* value during display. Visual data (Table 3) supports these results.

Ground dairy cow inside round, fattened with either beef 50/50 trim or cow 50/50 trim, had higher a* values throughout display than ground beef cow inside round (Table 2). By day 4, a* values of ground diary cow inside round were clearly superior ($P<0.001$) to ground beef cow inside round. Visual data (Table 4) supports these results.

## Implications:

The inclusion of muscles low in color stability at levels greater than 25% will cause negative effects on color life of ground beef. Moreover, the use of muscles with high color stability can be optimally managed to lengthen the display life of ground beef. Ground beef made from dairy cow muscle has superior color display life properties compared with ground beef from beef cows.

Results of this study offer much-needed information on how to better manage ground beef from cows by including or excluding certain muscles as needed and also by including ground beef from dairy cows. The potential for adding value to cull cows is clearly evident, provided that lean is managed in the most optimal way.

**Table 1. a*(redness) Least Squares Means for Ground Beef Patties Sourced From Muscles of High, Intermediate, and Low Color Stability, Formulated to 80% and 90% Lean Points, and Displayed for 4 Days**

| | Day 0 | | Day 2 | | Day 4 | |
|---|---|---|---|---|---|---|
| Treatment | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 |
| 75% high + 25% low | 30.46$^{a}$ | 27.34$^{b}$ | 26.61$^{b}$ | 25.20$^{b}$ | 23.41$^{b}$ | 19.85$^{c}$ |
| 50% high + 50% int. | 30.52$^{a}$ | 30.98$^{a}$ | 17.46$^{d}$ | 20.12$^{c}$ | 16.47$^{d}$ | 14.87$^{e}$ |
| 50% high + 50% low | 30.10$^{ab}$ | 30.87$^{a}$ | 14.44$^{e}$ | 14.55$^{e}$ | 10.70$^{h}$ | 13.73$^{eg}$ |
| 50% int. + 50% low | 31.48$^{a}$ | 33.09$^{a}$ | 11.70$^{g}$ | 13.49$^{f}$ | 12.50$^{g}$ | 12.08$^{g}$ |
| 33% high + 33% int. + 33% low | 30.02$^{ab}$ | 26.45$^{b}$ | 18.12$^{d}$ | 20.50$^{c}$ | 12.45$^{g}$ | 13.49$^{eg}$ |
| 25% high + 75% low | 32.20$^{a}$ | 31.79$^{a}$ | 19.46$^{cd}$ | 18.00$^{d}$ | 10.05$^{h}$ | 12.95$^{eg}$ |

$^{a-h}$Means within a row or column without a common superscript letter differ ($P<0.05$).

**Table 2. a* Least Squares Means for Ground Beef Patties Sourced from Dairy Cows and Beef Cows, Formulated to 80% and 90% Lean Points with Young or Mature Beef Fat, and Displayed for 4 Days**

| Treatment | | Day 0 | | Day 2 | | Day 4 | |
|---|---|---|---|---|---|---|---|
| Lean Source | Fat Source | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 |
| Beef | Beef trim | 27.29$^{b}$ | 25.36$^{bc}$ | 13.62$^{g}$ | 11.79$^{h}$ | 10.46$^{i}$ | 10.22$^{i}$ |
| Beef | Cow trim | 27.95$^{b}$ | 27.67$^{b}$ | 17.65$^{f}$ | 16.71$^{f}$ | 12.06$^{g}$ | 13.28$^{g}$ |
| Dairy | Beef trim | 29.60$^{a}$ | 29.37$^{a}$ | 23.40$^{d}$ | 25.37$^{c}$ | 18.26$^{ef}$ | 20.01$^{e}$ |
| Dairy | Cow trim | 30.34$^{a}$ | 29.88$^{a}$ | 27.30$^{b}$ | 26.26$^{bc}$ | 24.64$^{cd}$ | 26.28$^{c}$ |
| Beef + Dairy | Beef trim | 29.43$^{a}$ | 28.24$^{ab}$ | 18.62 | 20.20$^{e}$ | 14.77$^{g}$ | 17.83$^{f}$ |
| Beef + Dairy | Cow trim | 29.09$^{a}$ | 29.18$^{a}$ | 22.03$^{d}$ | 23.82$^{d}$ | 18.93$^{ef}$ | 20.22$^{e}$ |

$^{a-i}$Means within a row or column without a common superscript letter differ ($P<0.05$).

**Table 3. Display Color Score[a] for Ground Beef Patties Sourced from Muscles of High, Intermediate, and Low Color Stability, Formulated to 80% and 90% Lean Points, and Displayed for 4 Days**

| | Day 0 | | Day 1 | | Day 2 | | Day 3 | | Day 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 |
| 75% high + 25% low | 1.8[b] | 2.1[b] | 2.2[b] | 2.4[c] | 2.8[cd] | 3.1[d] | 3.2[d] | 3.3[d] | 6.3[i] | 6.7[ij] |
| 50% high + 50% int. | 2.0[b] | 2.1[b] | 2.6[c] | 2.7[cd] | 3.7[e] | 4.4[ef] | 3.5[d] | 4.6[f] | 7.2[j] | 7.0[ij] |
| 50% high + 50% low | 2.4[c] | 2.5[c] | 3.2[d] | 3.4[d] | 5.4[g] | 5.8[h] | 3.8[e] | 3.9[e] | 8.0[k] | 8.0[k] |
| 50% int. + 50% low | 3.4[d] | 3.4[d] | 3.8[e] | 3.9[e] | 5.1[f] | 5.9[h] | 5.9[h] | 6.0[h] | 8.0[k] | 7.9[k] |
| 33% high + 33% int. + 33% low | 3.1[d] | 3.3[d] | 3.3[d] | 3.6[de] | 4.7[f] | 5.0[f] | 4.6[f] | 5.5[g] | 8.0[k] | 8.0[k] |
| 25% high + 75% low | 3.8[e] | 4.1[e] | 4.0[e] | 4.2[e] | 6.7[i] | 6.5[i] | 7.6[jk] | 7.5[j] | 8.0[k] | 8.0[k] |

[a]1 = very bright red or pinkish red, 2 = bright red or pinkish red, 3 = dull red or pinkish red, 4 = slightly dark red or pinkish red, 5 = reddish tan or pinkish tan, 6 = moderately dark red or reddish tan or moderately dark pinkish red or pinkish tan, 7 = tannish red or tannish pink, and 8 = tan to brown.
[b-k]Means within a row or column without a common superscript letter differ ($P<0.05$).

**Table 4. Display Color Score[a] Means for Ground Beef Patties Sourced from Dairy Cows and Beef Cows, Formulated to 80% and 90% Lean Points, and Displayed for 4 Days**

| Treatment | | Day 0 | | Day 1 | | Day 2 | | Day 3 | | Day 4 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lean Source | Fat Source | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 | 80/20 | 90/10 |
| Beef | Beef trim | 1.8[b] | 2.2[b] | 3.8[de] | 3.6[d] | 5.8[g] | 6.0[g] | 6.6[h] | 6.3[gh] | 7.7[ii] | 7.2[hi] |
| Beef | Cow trim | 2.1[b] | 2.0[b] | 3.5[d] | 3.7[d] | 5.1[f] | 5.0[f] | 5.3[f] | 5.5[fg] | 6.8[h] | 6.7[h] |
| Dairy | Beef trim | 3.2[c] | 3.4[cd] | 3.3[c] | 3.5[d] | 3.2[c] | 3.4[cd] | 5.4[f] | 4.9[f] | 5.3[f] | 5.0[f] |
| Dairy | Cow trim | 3.6[d] | 3.3[cd] | 3.0[c] | 3.3[c] | 3.0[c] | 3.1[c] | 3.7[d] | 3.7[d] | 4.6[e] | 4.4[e] |
| Beef + Dairy | Beef trim | 2.9[c] | 3.0[c] | 3.6[d] | 3.8[de] | 4.2[e] | 4.4[e] | 5.8 | 5.7[g] | 6.2[gh] | 6.3[gh] |
| Beef + Dairy | Cow trim | 3.3[cd] | 3.5[d] | 3.4[cd] | 3.2[c] | 3.6[d] | 3.6[d] | 4.0[e] | 4.2[e] | 5.5[fg] | 5.7[g] |

[a]1 = very bright red or pinkish red, 2 = bright red or pinkish red, 3 = dull red or pinkish red, 4 = slightly dark red or pinkish red, 5 = reddish tan or pinkish tan, 6 = moderately dark red or reddish tan or moderately dark pinkish red or pinkish tan, 7 = tannish red or tannish pink, and 8 = tan to brown.
[b-i]Means within a row or column without a common superscript letter differ ($P<0.05$).