Evaluation of Ground Beef Quality from Commodity and Premium Quality Trimmings

D. Griffing¹, N. Myers¹, J. Crosswhite¹, C. Carr¹, D. Johnson¹, and C. Sims²

The purpose of this study was to evaluate the differences between ground beef quality manufactured with premium or commodity trimmings. Results from this study suggest that higher quality lean inputs are not necessarily different.

Summary

Round subprimals were sourced from cows (COW), fed upper 2/3 Choice beef carcasses (TC), or fed beef carcasses with Slight or Small marbling (COM), and used as lean sources, while boneless plates from TC and COM carcasses were utilized as fat sources. Lean and fat sources were mixed and ground to make 80 and 90% lean patties representing all 12 possible combinations. Patties manufactured with COW as a lean source had greater subjective values lean color and were objectively a more optimal red at the beginning of retail display, however, these patties also had the greatest reduction in color stability by the conclusion of retail display. Trained sensory panelists found few differences for lean source and no differences for fat source, while consumer panelists found no differences (P ≥ 0.22) for overall acceptability or flavor between patties manufactured with different lean or fat sources. The 80% lean patties produced lower Lee-Kramer shear force values (P < 0.001) than 90% lean patties. Lean source had greater influence than fat source on retail color. Additionally, patties containing COW lean began retail display at a more ideal retail color, but declined more rapidly than TC or COM lean patties. Lean and fat source had marginal impact on consumer or trained sensory palatability.

Introduction

Over 42% of per capita U.S. beef consumption has been as ground product over the past 30 yr, making it clearly the most consumed beef product in the United States (NCBA, 2006). The recent economic recession has led to an additional shift in demand from steaks and roasts toward ground beef, partially driven by the lower cost of ground products and the ability of ground beef to produce low cost meals. Currently, many retail and food service establishments are marketing ground beef from premium quality trimmings such as upper 2/3 Choice raw materials for added value; however, no known recent work has documented the differences between ground beef quality manufactured with premium or commodity trimmings. Therefore, the objective of this research was to evaluate the differences in ground beef between commodity and premium quality trimmings.

Materials and Methods

Raw Materials

Raw materials for ground beef processing were collected at 48-h postmortem from a commercial beef processing facility on two sampling dates, for the two respective project replicates. The right sides of 37 carcasses were selected for fabrication by plant personnel over the two sampling dates. Non-fed, beef-type cow carcasses (COW) and grain-fed, beef-type steer or heifer carcasses (FED) from one commercial plant were identified and distinguished from grain-fed, beef-type cow carcasses and grain-fed and non-fed, dairy-type cow carcasses, by utilizing carcass weight, subjective external fat thickness and color, and carcass conformation. Skeletal maturity was determined by trained, University of Florida personnel as selection criteria, within COW and FED populations. All COW carcasses selected displayed E skeletal maturity and were estimated to be USDA

¹Department of Animal Sciences, University of Florida, Gainesville, FL
²Department of Food Science and Human Nutrition, University of Florida, Gainesville, FL
Utility, while all FED carcasses selected displayed a skeletal maturity. The FED carcasses were ribbed between the 12th and 13th ribs by plant personnel, and USDA marbling scores were used as selection criteria by university personnel within the FED population to identify two carcass types. Carcasses (n = 6, per date) were selected to have a Modest or Moderate degree of marbling (Top Choice; TC) and (n = 3, per date) were selected to have a Slight or Small degree of marbling, respectively (Commodity; COM). Hot carcass weight was recorded from carcasses of all populations, and for the FED carcasses, fat thickness and longissimus muscle area were measured, the percentage of KPH fat was estimated, lean maturity and marbling score were evaluated by university personnel for the calculation of USDA yield grades (USDA-AMS, 1997).

**Patty Manufacturing**

Untrimmed inside rounds (IMPS #168) and outside round flats (IMPS #171B) were collected from COW carcasses to be used as a lean source. These round subprimals, as well as boneless plates (IMPS #121) were collected from TC and COM carcasses to be used a fat source. Lean sources and fat sources were combined to produce 80 and 90 % lean hamburger patties representing all 12 combinations: lean source (3) × fat source (2) × lean percentage (2).

**Retail Color Evaluation**

Ground beef was displayed in a Hill (Hill Refrigeration Div., Trenton, NJ) coffin-style retail case at 36 +/- 6°F for 4 d. Packages were rotated daily to compensate for uneven temperature and light distribution within the case. Using a whole number scale, a 6 to 8 member trained panel evaluated each ground beef patty daily for 5 d, for lean color (1= Extremely dark red to 8= Extremely bright cherry red) and percentage surface discoloration (1= none= 0% to 7= complete=100%). Objective lean color analysis (L*: a measure of darkness to lightness, a*: a measure of redness, and b*: a measure of yellowness) was conducted averaged using a Hunter Miniscan XE Plus [Hunter Laboratory, Reston, VA]on the surface of each ground beef patty daily for 5 d in duplicate and. Hunter L*, a*, and b* values were then used to calculate chroma (a measure of total color), which was calculated according to standard equations.

**Cooking**

Frozen patties were cooked for all assessments on an open hearth, variable heat grill (Model 31605 AH, Hamilton Beach/Proctor-Silex Inc., Southern Pines, NC). Patties were turned once at an internal temperature of 80°F and were allowed to finish cooking, reaching an internal temperature of 160°F (AMSA, 1995). For trained sensory and Lee-Kramer shear force, temperature was monitored using copper-constantan thermocouples placed in the geometric center of each patty connected to a recording thermometer (Omega Engineering Inc., Stamford, CT) and recorded using a 1100 Labtech Notebook for Windows 1998 (Computer Boards Inc., Middleboro, MA). For consumer sensory evaluation, temperatures were monitored during cooking using a hand-held thermometer (Type K Microprocessor thermometer, Control Company, Friendswood, TX) according to the same cooking protocol.

**Trained Sensory Evaluation**

For each replicate, panelists evaluated 3 patties from the 12 combinations over 6 sensory sessions. Only 1 patty from each combination was allotted to each sensory event. Panelists evaluated 6 samples per event, 2 cubes (0.5 in³) per sample. A 7–11 member sensory panel trained according to AMSA sensory evaluation guidelines (AMSA, 1995) evaluated each ground beef sample on an 8 point scale for beef flavor, juiciness, and firmness (1 = extremely bland, extremely dry, extremely soft to 8 = extremely intense, extremely juicy, extremely firm), on a 6 point scale for off-flavor (1 = extreme off-flavor to 6 = no off-flavor detected) and on a 5 point scale for greasiness (1 = extremely greasy to 5 = not greasy).

**Consumer Sensory Evaluation**

A total of 87 and 94 consumers consumed ground beef patties from the 12 lean source × fat source × lean percentage combinations, for the 2 replicates. For each day of evaluation, a given lean percentage was designated and patties from 3 lean source × fat source combinations were chosen randomly. Patties from each of the day’s
selected three combinations were cooked as described earlier for each panel session. Consumers evaluated all samples for flavor, juiciness, texture, and overall acceptability on a 9-point hedonic scale (1 = dislike extremely; 5 = neither like nor dislike; 9 = like extremely).

Statistics
All data were analyzed as a full factorial design with 3 factors, lean source (3) × fat source (2) × lean percentage (2) using the mixed model procedure of SAS (SAS Inst., Inc., Cary, NC). Sensory event was used as a random variable in the analysis of all other trained and consumer sensory traits. Replicate was used as a random variable in all models. Display day was included in the repeated measures analysis of objective and subjective retail evaluation, with retail package being the experimental unit. Least square means were calculated for main and interactive effects and separated statistically using pair-wise t-tests (P-DIFF option of SAS) when a significant (P < 0.05) F-test was detected.

Results
Fat source had a marginal effect on the objective color of beef patties during retail display (Table 1). As expected, 80% lean patties were lighter (P < 0.001) and less red than 90% lean patties (Table 1). Lean source had a greater influence than fat source on retail color. Patties manufactured with COW as a lean source had greater subjective values for lean color (Figure 1) and were objectively a more optimal red at the beginning of retail display; however, these patties also discolored more quickly (Figure 1). Patties formulated with COW lean had the greatest change related to color traits; becoming less red (lower a* value), and less vivid (lower chrome value) during retail display when compared to COM and TC lean patties (Figure 2). Patties made with TC lean were less yellow (lower b* values; P < 0.05) throughout the 5 d of retail display, while COW and COM lean patties followed similar trends (Figure 2). Trained sensory panelists found marginal or no differences in patties manufactured with different lean or fat sources (Table 2). Additionally, trained sensory panelists found 80% lean patties to be juicier, softer, and greasier and to contain more off-flavor (P < 0.03), than 90% lean patties (Table 2). Consumers gave 80% patties greater ratings for likeness of flavor (P = 0.05), and tended to give them greater ratings for overall acceptability (P = 0.06), compared to 90% lean patties (Table 2). Consumer panelists found no differences in likeability for overall acceptability or flavor between patties manufactured with different lean or fat sources. Consumer sensory panelists found no differences (P ≥ 0.22) in flavor or overall acceptability of patties, regardless of lean source or fat source (Table 3). Lean and fat source had marginal impact on consumer or trained sensory palatability.

Literature Cited

Acknowledgements
The authors thank the Beef Checkoff for funding this project.
### Table 1. Effect of fat source and lean percentage on objective color of beef patties.

<table>
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<tr>
<th>Trait</th>
<th>Fat source</th>
<th>Lean percentage</th>
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<th>90</th>
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<tr>
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<td>COM</td>
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<tr>
<td></td>
<td>40.75</td>
<td>41.07</td>
<td>0.15</td>
<td>44.02</td>
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<td>a*</td>
<td>14.69</td>
<td>15.71</td>
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<td>14.48</td>
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<td>b*</td>
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<td>17.97</td>
<td>0.31</td>
<td>16.92</td>
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</table>

a 55.0 – 59.0 % lean beef product sourced from TC = A-maturity carcasses with Modest or Moderate degrees of marbling; COM = A-maturity carcasses with Slight or Small degrees of marbling.

L* = measure of darkness to lightness (larger value indicates a lighter color); a* = a measure of redness (larger value indicates a redder color); b* = a measure of yellowness (larger value indicates a more yellow color).

### Table 2. Effect of lean source, fat source and lean percentage on trained sensory traits of beef patties.

<table>
<thead>
<tr>
<th>Trait</th>
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<th>Fat source</th>
<th>Lean percentage</th>
<th>P-Diff</th>
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<tbody>
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<td>COM</td>
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<tr>
<td>Texture</td>
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<td>6.01</td>
<td>5.99</td>
<td>0.96</td>
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</table>

a 93.25- 97.25 % lean beef product sourced from COW = USDA Utility carcasses; TC = A-maturity carcasses with Modest or Moderate degrees of marbling; COM= A-maturity carcasses with Slight or Small degrees of marbling.

b 55.0 – 59.0 % lean beef product sourced from TC = A-maturity carcasses with Modest or Moderate degrees of marbling; COM = A-maturity carcasses with Slight or Small degrees of marbling.

8 = extremely intense, extremely juicy, extremely firm, 1 = extremely bland, extremely dry, extremely soft
6 = no off-flavor detected, 1 = extreme off-flavor.
5 = not greasy, 1 = extremely greasy.

Values lacking a common superscript within lean source are different (P ≤ 0.023).
Figure 1. Interactive effect of lean source\textsuperscript{a}, lean percentage and day of retail display on subjective lean color\textsuperscript{b} values ($P = 0.005$). \textsuperscript{a}93.25-97.25% lean beef product sourced from COW = USDA Utility carcasses; TC = A-maturity carcasses with Modest or Moderate degrees of marbling; COM = A-maturity carcasses with Slight or Small degrees of marbling. \textsuperscript{b}1 = Extremely dark red, 2 = Dark red, 3 = Moderately dark red, 4 = Slightly dark red, 5 = Slightly bright cherry red, 6 = Moderately bright cherry red, 7 = Bright cherry red, 8 = Extremely bright cherry red.
Figure 2. Interactive effect of lean source* and day of retail display on lightness (L*) values ($P = 0.002$), redness ($a^*$) values ($P < 0.001$), yellowness ($b^*$) values ($P = 0.049$), and chroma values (a larger number indicates a more vivid color; $P < 0.001$) of beef patties. *93.25-97.25 % lean beef product sourced from COW = USDA Utility carcasses; TC = A-maturity carcasses with Modest or Moderate degrees of marbling; COM = A-maturity carcasses with Slight or Small degrees of marbling.