Grass silage versus maize silage effects on retail packaged beef quality


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ABSTRACT: The effects of three preslaughter diets on heifer beef quality were investigated. Heifers (n = 45) were divided into three groups and fed for ad libitum consumption either maize silage, grass silage, or a 50:50 mixture of maize silage and grass silage. Meat quality was determined by measuring color, lipid oxidation, α-tocopherol levels, and fatty acid composition. Beef from the maize silage group had poorest color stability (P < 0.05), whereas beef from the grass silage diet had best (P < 0.05) color stability. The visual panel least preferred the maize silage group after 2 or more days of display, and lipid oxidation was significantly (P < 0.001) higher in this group compared to the 50:50 maize:grass silage and grass silage groups. There was a significant (P < 0.001) difference in the α-tocopherol levels detected in the meat from the three dietary groups. α-Tocopherol levels increased in the order: maize silage < 50:50 maize:grass silage < grass silage, at levels of 2.08, 2.95, and 3.84 μg/g meat, respectively. Fatty acid analysis indicated 18:3 was significantly (P < 0.001) lower in the maize silage-fed group than in the maize:grass silage and grass silage groups. However, 18:3 was significantly (P < 0.001) higher in the grass silage group than in the other two groups. There were no significant differences in all other fatty acids among the three dietary groups. It was concluded that beef from grass silage-fed animals had better overall quality in terms of color, lipid oxidation, and α-tocopherol levels than beef from maize silage fed animals.

Key Words: Beef Quality, Grass Silage, Maize Silage, Polyenoic Fatty Acids, Rancidity, Vitamin E

Introduction

The main factors influencing the eating quality of meat are tenderness, color, and flavor (Buckley et al., 1995). At the point of sale, color and color stability are the most important attributes of meat quality. Consumers equate an attractive bright red color with long shelf-life and good eating quality, and various approaches have been used to meet this expectation (Hood and Mead, 1993). Of the production factors affecting meat color and quality, the dietary regime of the animals is one of the most important. Studies on forage finishing of beef have produced mixed results on carcass characteristics and palatability attributes. Fortin et al. (1985) found no differences in palatability attributes between forage- and grain-finished beef. Crouse et al. (1984) reported that steaks from grass-fed heifers were similar to those from grain-fed heifers in terms of tenderness, juiciness, and flavor but darker in color during retail display. Smith (1990) discouraged forage finishing of beef due to its lower dressing percentage, decreased quality grade, yellow fat color, dark muscle color, and decreased flavor and tenderness in favor of grain-finished beef.

Grass silage is the predominant forage in the diet of Irish beef cattle finished indoors, and a number of studies (French et al., 2000a, Steen and Kilpatrick, 2000) have examined the effects of feeding grass silage-based diets to beef cattle. In recent years, however, there has been increased interest in growing forage maize in new geographical areas, which are climatically favorable, conserving it as silage and using it as a forage that is complementary or alternative to grass silage in the diet of beef cattle. Because there is little information on the effect of maize silage on meat quality, this experiment was designed to determine the impact of substituting grass silage with maize silage in the diet of cattle on the quality of beef held under two forms of retail packaging: overwrapping and modified atmosphere packaging (MAP).
**Materials and Methods**

**Chemicals**

All chemicals used were AnalaR grade obtained from British Drug House, Poole, Dorset, U.K.; Sigma Chemical Co., Ltd., Poole, Dorset, U.K.; and Rathburn Chemical Co., Ltd., Walkerburn, Peabshire, Scotland.

**Cattle and Diets**

The experiment was carried out at Teagasc, Grange Research Centre, Co. Meath, Ireland. In a randomized complete block (body weight) design, Charolais cross-bred heifers (n = 45) were divided into three groups. Group 1 consumed maize silage ad libitum, Group 2 consumed 500 g of maize silage + 500 g of grass silage (perennial ryegrass)/kg DM ad libitum, and Group 3 consumed grass silage ad libitum. All treatments included 3 kg concentrates/(animal-d). The age of the animals was 15 mo at the start of the experiment, and the duration of the feeding period was 167 d preceding slaughter. Initial live weights were 443, 442, and 443 kg for the maize silage, maize:grass silage, and grass silage groups, respectively, and finishing live weights were 615, 596, and 589 kg for the maize silage, maize:grass silage and grass silage groups, respectively.

**Slaughter and Beef Sampling**

Animals were slaughtered in a commercial abattoir. After slaughter, carcasses were held for 24 h at 4°C and then cold-boned. Samples of longissimus dorsi muscle were vacuum packed and aged at 4°C for 2 d postmortem; steaks 2.5 cm thick were then cut for color analysis. The steaks were then vacuum packed and frozen at −30°C for subsequent analysis.

**Packaging**

*Overwrapped (Aerobic Packaging)*. Duplicate meat cores (2.5 cm diameter) and steaks (2.5 cm thick) were individually placed in polystyrene/ethylvinylalcohol (EVOH)/polyethylene (PE) trays. Meat samples were overwrapped with oxygen-permeable (6000 to 8000 cm³/[m²·h]) lidding material consisting of a laminate of 20-μm oriented polypropylene and a coextrusion layer (50-μm) of PE/EVOH/PE supplied by Cryovac, W.R. Grace Europe Inc., Av. Montchoisi 35, 1001 Lausanne, Switzerland. Samples were packed using a packaging machine type VS 100 BS (Gustav Muller and Co., Zum Wingert 5, 6380 Bad Homburg 6, Germany).

**Determination of α-Tocopherol (Muscle Tissue and Feeds)**

One-gram duplicate samples were taken from each steak within each dietary group and analyzed for α-tocopherol content. α-Tocopherol was extracted using the method of Sheehy et al., 1993 and quantified by HPLC using a Waters model S10 pump, a Waters 717 autosampler, a Machery-Nagel Nucleosil 5 C18 (250 × 0.4 mm) reverse-phase column, and a Waters model 486 UV-visible wavelength detector (Millipore Corporation, Milford, MA) set at 292 nm. The mobile phase was methanol:water (97:3) at a flow rate of 2 mL/min. Data were recorded and integrated using the Millennium 32 Chromatography Manager (Millipore Corporation).

The procedure for determining the α-tocopherol in the feed samples was identical to that for muscle tissue with the exception that 0.1 g of feed sample was used.

**Fatty Acid Analysis of Beef and Feeds**

Total lipid for fatty acid analysis was extracted from meat and feeds using the method of Folch et al. (1957). Fatty acid methyl esters were prepared according to the procedure of Slover and Lanza (1979). Gas chromatographic analysis was carried out using a Shimadzu (Model GC-14A) gas chromatograph with flame ionization detection, equipped with a Shimadzu (Model AOC-17) autoinjector. The column used was a DB-WAX fused-silica capillary column (25 m × 0.32 mm, i.d., film thickness of 0.25 μm, J&W Scientific, CA). The carrier gas was nitrogen at a pressure of 1 kg/cm². Oven temperature programming was as follows: 50 to 200°C at 10°C/min and held isothermally at 200°C for 37 min and increased to 230°C at 10°C/min and held isothermally for 38 min. The injector port and detector temperature was 250°C. Chromatograms were processed using the Millennium 32 Chromatography Manager (Millipore Corporation, Milford, MA, USA).

**Determination of Color**

Hunter “a” values of meat cores were measured in duplicate after d 0, 2, 4, 6, 8, 10, 12, and 17 using a Minolta Chromameter CR-300 (Minolta Camera Co., Osaka 541, Japan). The proportion of the pigment myoglobin was determined in duplicate using the method of Krzywicki (1979) and a Perkin-Elmer Lambda 2 UV/Vis spectrophotometer equipped with an integrating sphere (Perkin Elmer, Bucks H99 1QA, England).

**Visual Assessment of Beef**

A semitrained panel of 15 was asked to examine the meat color on the same days as instrumental color analysis was carried out. Two displays of meat were shown...
to panelists, one display being the aerobically packaged meat and the other being the MAP meat. Within each display, there were three trays of meat, one tray for each dietary group. Panelists were asked to make the following choices: 1) to choose their most preferred and least preferred tray of meat within the aerobic display, 2) to choose their most preferred and least preferred tray of meat within the MAP display, and (3) to choose their most preferred dietary group from both displays.

**Determination of Oxidative Stability**

The extent of lipid oxidation was determined by the TBA (2-thiobarbituric acid) assay using the distillation method of Tarladgis et al., 1960 as modified by Ke et al., 1977. Results were expressed as thiobarbituric acid-reactive substances (TBARS) numbers in the unit of milligrams of malonaldehyde per kilogram of meat sample. Lipid oxidation was measured in duplicate at d 0, 2, 4, 6, 8, 12, and 17 for both aerobically packaged and MAP samples.

**Statistical Analyses**

A full repeated-measure ANOVA was conducted for each packaging type (Aerobic and MAP) to investigate the effect of diet and time and the interaction of diet and time. Diet represented the between-subjects factor, where subjects are heifers in this case. The effect of day was measured within-subjects, and multiple measurements were made for the same animal. Tukey’s test was used to adjust for multiple comparisons (Neter et al., 1990). For vitamin E and fatty acids, one-way analysis of variance was used to test for diet effects. Tukey’s test was again used for multiple comparisons. Sensory data was analysed using the chi-square test. The analysis was carried out using the SPSS 8.0 for Windows (SPSS, Chicago, IL) software package.

**Results**

**Hunter “a” Values**

In aerobically packed samples, no significant effect of diet on Hunter “a” values was observed. There was a significant ($P < 0.05$) day × diet interaction; however, multiple comparisons of the dietary groups on each day did not reach a significant level. Trends showed that, from d 6 to 17, the grass silage group had higher Hunter “a” values than the 50:50 maize:grass silage and maize silage groups (Figure 1). There was a significant ($P < 0.001$) day effect, where there was a similar gradual decrease in Hunter “a” values for the three dietary groups over time. There was a significant ($P < 0.001$) day × diet interaction. Trends showed that the maize silage group had lowest Hunter “a” values, particularly from d 8 to 17, but these differences were not significantly lower.

**Metmyoglobin Formation**

In the aerobically packed samples (Figure 3), there was a significant ($P < 0.05$) difference in the proportion of metmyoglobin among the three dietary groups. The grass silage fed group had a significantly ($P < 0.05$) lower proportion of metmyoglobin than the 50:50 maize:grass silage group. Overall, this group also had a lower proportion of metmyoglobin than the maize silage-fed group, but it was not significantly lower. There was no significant day × diet interaction. There was a significant ($P < 0.001$) time effect; the proportion of metmyoglobin increased over time in the three dietary groups.

**Figure 1.** Hunter “a” values for aerobically packed samples stored under display conditions at 4°C, 616 lx, for 17 d. (◆) Maize silage, (■) 50:50 maize:grass silage, (▲) grass silage.

**Figure 2.** Hunter “a” values for modified atmosphere packaging samples (80:20 O₂:CO₂) stored under display conditions at 4°C, 616 lx, for 17 d. (◆) Maize silage, (■) 50:50 maize:grass silage, (▲) grass silage.
Figure 3. Proportion of metmyoglobin (MetMb) in aerobically packed samples stored under display conditions at 4°C, 616 lx, for 17 d. (◆) Maize silage, (■) 50:50 maize:grass silage, (▲) grass silage.

In the MAP samples (Figure 4), there was no significant effect of diet on the proportion of metmyoglobin formed. There was a significant ($P < 0.01$) day × diet interaction. No trend was observed until d 12 through 17. By d 12, the maize silage group had higher proportions of metmyoglobin than both the 50:50 maize:grass silage and grass silage groups, but these did not reach significant levels. On d 17, the maize silage group had significantly higher levels than the 50:50 maize:grass silage ($P < 0.01$) and grass silage ($P < 0.001$) groups. There was a significant time ($P < 0.001$) effect, with the proportion of metmyoglobin increasing with time for all dietary groups.

Sensory Analysis

The panel’s most and least preferred beef under MAP are shown in Figure 5. On d 2 and 6, the 50:50 maize:grass silage beef was most preferred, whereas on d 8 and 12 the grass silage beef was most preferred. On d 2, 6, 8, and 12, maize silage beef was least preferred. The panel’s most preferred beef for both forms of packaging is shown in Figure 6. On day 0, the maize silage under aerobic packaging was most preferred by the panel. On days 2 to 6, the 50:50 maize:grass silage under MAP was most preferred. On days 8 to 12, the grass silage under MAP was clearly most preferred by the panel.

Oxidative Stability

In the aerobically packed samples, there was a significant ($P < 0.001$) difference in TBARS numbers among all three dietary groups (Figure 7). There was also a significant ($P < 0.001$) day × diet interaction. On d 4, 8, and 12, the maize silage group had significantly ($P < 0.001$) higher TBARS numbers than did the 50:50 maize:grass silage and the grass silage group. On d 8 and 12, the grass silage group had significantly lower TBARS numbers than the maize silage group ($P < 0.01$ and $P < 0.001$, respectively) and the 50:50 maize:grass silage group ($P < 0.05$ and $P < 0.001$, respectively).

Figure 4. Proportion of Metmyoglobin (MetMb) in modified atmosphere packaging samples (80:20 O₂:CO₂) stored under display conditions at 4°C, 616 lx, for 17 d. (◆) Maize silage, (■) 50:50 maize:grass silage, (▲) grass silage.

Figure 5. Panelist’s most preferred and least preferred dietary group under modified atmosphere packaging (80:20 O₂:CO₂). MS: maize silage, GS: grass silage.

Figure 6. Panelist’s overall preferred dietary group looking at both forms of packaging, aerobic and modified atmosphere packaging (80:20 O₂:CO₂). MS: maize silage, GS: grass silage.
In the MAP samples, there was a significant (P < 0.001) difference in TBARS numbers between all three dietary groups (Figure 8). The maize silage group had highest TBARS numbers and the grass silage group had lowest TBARS numbers on all days after day 0. There was also a significant day × diet (P < 0.001) interaction. On d 2, 4 and 12 the maize silage group had significantly (P < 0.001) higher TBARS numbers than the 50:50 maize:grass silage, and grass silage groups. On d 8, the maize silage group had significantly (P < 0.001) higher TBARS numbers than the grass silage group. It also had higher TBARS numbers than the 50:50 maize:grass silage group, but values were not significantly different. On d 8 and 12, the grass silage group had significantly lower TBARS numbers than the maize silage and 50:50 maize:grass silage groups (P < 0.05 and P < 0.001) respectively. TBARS numbers were significantly (P < 0.001) higher in the MAP samples compared to the aerobically packaged samples.

**α-Tocopherol Content**

There was a significant (P < 0.001) difference in the α-tocopherol levels of meat from the three dietary groups (Table 1). Levels increased in the order maize silage (2.08 µg/g) < 50:50 maize:grass silage (2.95 µg/g) < grass silage (3.84 µg/g) group. The grass silage group had significantly (P < 0.001) higher α-tocopherol levels than the 50:50 maize:grass silage and maize silage groups. The level of α-tocopherol in the feeds was 20.9 µg/g and 105.4 µg/g for maize silage and grass silage, respectively (Table 2).

**Fatty Acid Composition**

The percentage fatty acid composition of meat from the three dietary groups is shown in Table 1. The only fatty acid that differed significantly among the three dietary groups (P < 0.001) was 18:3. It was significantly lower (P < 0.001) in the maize silage fed group compared to the 50:50 maize:grass silage and grass silage groups.

### Table 1. Percentage fatty acid composition and α-tocopherol (vitamin E) content of meat from the three dietary groups

<table>
<thead>
<tr>
<th>Item</th>
<th>Maize silage</th>
<th>50:50</th>
<th>Grass silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatty acid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0.14</td>
<td>0.15</td>
<td>0.18</td>
</tr>
<tr>
<td>14</td>
<td>3.38</td>
<td>3.49</td>
<td>3.54</td>
</tr>
<tr>
<td>16</td>
<td>35.96</td>
<td>34.69</td>
<td>36.88</td>
</tr>
<tr>
<td>16:1</td>
<td>5.05</td>
<td>3.40</td>
<td>4.06</td>
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<tr>
<td>18</td>
<td>9.54</td>
<td>8.57</td>
<td>9.11</td>
</tr>
<tr>
<td>18:1</td>
<td>39.26</td>
<td>42.05</td>
<td>38.32</td>
</tr>
<tr>
<td>18:2</td>
<td>5.87</td>
<td>6.27</td>
<td>6.13</td>
</tr>
<tr>
<td>18:3</td>
<td>0.796a</td>
<td>1.37b</td>
<td>1.78c</td>
</tr>
<tr>
<td>Vitamin E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>µg/g</td>
<td>2.08</td>
<td>2.95</td>
<td>3.84</td>
</tr>
</tbody>
</table>

*aValues with different superscripts within each row differ significantly at P < 0.05.

### Table 2. Percentage fatty acid composition and α-tocopherol content of feeds

<table>
<thead>
<tr>
<th>Item</th>
<th>Maize silage</th>
<th>Grass silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatty acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0.47 ± 0.03</td>
<td>0.51 ± 0.06</td>
</tr>
<tr>
<td>14</td>
<td>1.40 ± 0.12</td>
<td>4.94 ± 0.10</td>
</tr>
<tr>
<td>16</td>
<td>18.84 ± 0.48</td>
<td>19.29 ± 0.39</td>
</tr>
<tr>
<td>16:1</td>
<td>0.32 ± 0.02</td>
<td>2.49 ± 0.02</td>
</tr>
<tr>
<td>18</td>
<td>1.41 ± 0.04</td>
<td>1.18 ± 0.06</td>
</tr>
<tr>
<td>18:1</td>
<td>15.76 ± 0.21</td>
<td>4.47 ± 0.35</td>
</tr>
<tr>
<td>18:2</td>
<td>56.32 ± 0.56</td>
<td>19.79 ± 0.68</td>
</tr>
<tr>
<td>18:3</td>
<td>5.47 ± 0.25</td>
<td>47.31 ± 1.02</td>
</tr>
<tr>
<td>Vitamin E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>µg/g</td>
<td>20.76 ± 4.29</td>
<td>105.41 ± 10.05</td>
</tr>
</tbody>
</table>

*Means ± SEM.
and it was significantly \( P < 0.001 \) higher in the grass silage group compared to the other two groups. The percentage fatty acid composition of the feeds given to the animals is shown in Table 2. The maize silage feed had higher proportions of 18:1 and 18:2, and the grass silage feed had a higher proportion of C18:3.

**Discussion**

As there is little information on the effect of maize silage on beef quality, the objective of this experiment was to determine the impact of substituting grass silage with maize silage in the diet of finishing cattle on the quality of beef held under two forms of retail packaging, overwrapping and modified atmosphere packaging (MAP).

There was no overall significant difference in Hunter “a” values between meat from the three dietary groups held under both packaging conditions. However, trends showed that beef from the maize silage-fed group had lower mean Hunter “a” values than the 50:50 maize:grass silage and grass silage groups. This trend was particularly apparent in the latter days of the study and was more pronounced in the MAP samples. These results were not in agreement with those of Hoving-Bolink et al. (1999), who carried out a similar study to examine the effect of three diets (maize silage, prewilted grass, and a mixture of these) on carcass and meat quality of once-bred Piedmontese × Friesian heifers. Their results showed that the maize silage was the best diet because it produced better daily gain, better carcass conformation, and a lighter and more tender meat than the heifers fed the prewilted grass. In their study, the heifers that were fed the maize silage diet had loins that were more red in color, having a mean Hunter “a” value of 18.0 compared to 17.6 and 17.6 for the mixed and prewilted grass silage group, respectively. In the present study, the aerobically packed samples showed significant \( P < 0.05 \) difference in the proportions of metmyoglobin between the three dietary groups. The grass silage group had significantly \( P < 0.05 \) lower proportions of metmyoglobin than the 50:50 maize:grass silage and maize silage groups. In the MAP samples on d 12 and 17, the maize silage-fed group had highest proportions of metmyoglobin. In terms of overall color, the visual panel most preferred the grass silage group and least preferred the maize silage group. Kogel et al. (1998) examined the influence of grass silage, meadow hay, and maize silage on meat quality of heifers. Maize silage produced better \( P < 0.05 \) results than hay in regards to meat texture, consistency, drip losses, intramuscular fat content, marbling, and redness. Meat brightness was highest for the grass silage group and was significantly lower for the maize silage.

Gray et al. (1994) reported that the type of diet fed to meat-producing animals can influence meat flavor and lipid oxidation. When oxidative stability was assessed between the three dietary groups, the maize silage-fed group had highest TBARS numbers whereas the grass silage-fed group had lowest TBARS numbers. The 50:50 maize:grass silage group had TBARS numbers that were intermediary between these two dietary groups. This trend was observed in both packaging types for the duration of the trial. In this study, TBA values of 4 to 8 were high for raw meat samples (Figures 7 and 8); however, the storage time was long (12 d). In support of this finding Wilson et al. (1976) reported a TBA value of 0.95 for raw beef muscle at 1 d post-mortem.

Faustman et al. (1992) reported a strong relationship between lipid oxidation and myoglobin oxidation in veal during aerobic storage. Similar results were reported in beef (Faustman and Cassens, 1991; Gatellier et al., 1992; Mercier et al., 1995). The results of this study agreed with these findings. Under MAP conditions during the latter days of the study, the maize silage group had much higher proportions of metmyoglobin. This group was least preferred by the panel from d 6 to 12, and this group had significantly higher TBARS numbers than the other two dietary groups.

Modified atmosphere packs, containing high oxygen levels to support oxymyoglobin formation and carbon dioxide as an antimicrobial agent (e.g., 80% O₂:20% CO₂), are commonly used to extend the color shelf-life of red meats. However, in these packs the high oxygen content can in some instances promote oxidation and adversely affect color (Monahan, 2000). In the present study, TBARS numbers were higher overall for the MAP samples, in agreement with Kerry et al. (1996), who found that MAP promoted lipid oxidation in beef steaks and steak cores from cattle fed a control diet. This detrimental effect was offset or reduced by \( \alpha \)-tocopherol acetate supplementation. The native vitamin E content of muscle has been shown to be a critical determinant of the susceptibility of muscle stored in high oxygen packs to lipid oxidation (O’Grady et al., 1998). In the present study, there was a significant difference in \( \alpha \)-tocopherol levels between the three dietary groups \( P < 0.001 \). The grass silage group had significantly \( P < 0.01 \) higher \( \alpha \)-tocopherol levels than the 50:50 maize:grass silage and maize silage groups. The maize silage group had lowest \( \alpha \)-tocopherol levels (mean 2.08 \( \mu \)g/g of meat). Zust et al. (1995) studied the levels of vitamin E in cattle diets and found great variations in the vitamin E content, with values of 127, 77, and 32 mg/kg for grass silage, maize silage, and hay, respectively. A further study by Jukola et al. (1996) found that for hay, grass silage, oats, and barley, the levels of vitamin E were 39.7, 120.0, 24.4, and 35.5 IU/kg, respectively. Cattle fed diets with higher vitamin E levels (silage) had greater total vitamin E serum levels than animals on lower vitamin E diets (hay). In this study, the level of \( \alpha \)-tocopherol in the grass silage feed was 105.4 \( \mu \)g/g compared to 20.9 \( \mu \)g/g in the maize silage feed. Several studies have shown that dietary supplementation of vitamin E results in accumulation of \( \alpha \)-tocopherol in muscle tissue, which delays pigment and lipid oxidation (Houben et al., 2000; Kerry et al.,
2000; Lynch et al., 1999). The results of this study are in agreement with these findings. The grass silage group, which had greatest color stability and lowest level of lipid oxidation, had the highest level of vitamin E (mean 3.84 µg/g). The maize silage group, which had poorest color stability, had the greatest level of lipid oxidation and the lowest level of vitamin E (mean 2.08 µg/g). In this study, the maize silage diet, which exhibited highest lipid oxidation, had lowest α-tocopherol levels.

Larick and Turner (1989) reported that diet influences the polyunsaturated fatty acid composition of phospholipids in pectoralis. Access to rye and ryegrass pasture vs corn/corn silage or wheat/corn silage diets resulted in increased concentrations of 18:2, 18:3, 20:3, 20:4, and 22:5 fatty acids in the phospholipids fraction of the muscle. French et al. (2000b) found that high grass intake resulted in a higher ratio of polyunsaturated to saturated fatty acid and a lower n−6:n−3 PUFA ratio in intramuscular fat of steers than in that of similar steers fed concentrates. In this study, the grass silage feed had higher levels of 18:3 (47%) compared to the maize silage feed (5%). The maize silage feed in turn had much higher levels of 18:2 (56%) compared to the grass silage feed (20%). The high levels of 18:3 were also found in meat from the grass silage group, which had significantly ($P < 0.05$) higher levels than the other two groups. Meat from the maize silage group, however, did not have significantly higher levels of 18:2 compared to the other two groups.

**Implications**

Beef from grass silage-fed animals had better overall quality in terms of color, lipid oxidation, and vitamin E levels than beef from maize silage-fed animals. The results of this study show that if grass silage is substituted by maize silage in the diet of finishing cattle, it does not improve the quality of the beef held under retail display conditions; this finding is important from the consumer perspective.

**Literature Cited**


