Effect of Feeding Dried De-oiled Distillers Grains and Addition of Postmortem Antioxidants on Ground Beef Shelf Life

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Effect of Feeding Dried De-oiled Distillers Grains and Addition of Postmortem Antioxidants on Ground Beef Shelf Life

Jenae C. Martin, Brandy D. Cleveland, Tommi F. Jones, James C. MacDonald and Gary A. Sullivan

Summary

Ground beef patties from cattle fed either corn based diets with no distillers grains (control) or dried, de-oiled distillers grains (DDDG) during the finishing phase were compared to analyze color stability during retail display. As display time increased, patties with added antioxidant had less discoloration than those without antioxidant. Patties from cattle fed DDDG had the greatest discoloration when no antioxidant was included. Both raw and cooked ground beef from cattle fed DDDG had increased lipid oxidation towards the end of display than beef from corn-finished cattle. Furthermore, corn-finished cattle had lower concentrations of C18:2 in both composite and subcutaneous fat samples. Finishing cattle on DDDG resulted in reduced shelf life of meat products. Previous studies have shown the effectiveness of natural plant extracts reducing lipid oxidation in cooked beef links from cattle fed distillers grains (2015 Nebraska Beef Cattle Report, pp. 122–123) but have none have investigated the impacts in raw ground beef. Therefore, the objective of this study was to evaluate the impact of feeding dried de-oiled distillers grains during the finishing phase on raw and cooked ground beef and determine the impact of added antioxidants on shelf life of raw ground beef.

Introduction

As processing of distillers grains evolves, reevaluation of the effects on shelf life is necessary. In an effort to maximize value during ethanol processing, some processors have begun removing oil by centrifugation (30–40% of total oil content, DM basis). Dried de-oiled distillers grains are one current form of ethanol co-products for feeding cattle. Cattle fed ethanol co-products have an increase in concentrations of polyunsaturated fatty acids (PUFA; 2015 Nebraska Beef Cattle Report, pp. 122–123). The increase in PUFA may cause greater susceptibility to lipid oxidation and decreased shelf life, as lipid oxidation occurs most readily in polyunsaturated fatty acids. Raw ground beef patties from cattle fed ethanol co-products have been shown to discolor at a greater rate (2014 Nebraska Beef Cattle Report, pp. 105–106). Lipid oxidation and off-flavor development after cooking is accelerated due to the release of iron, free and heme-bound, from myoglobin during cooking. Lipid oxidation has been related to reduced shelf life and decreased overall desirability of the product because of evidence of “warmed over” or “rancid” flavors. The addition of plant extracts, such as cherry, rosemary and green tea, to fresh meats is becoming increasingly popular in meat processing as a natural antioxidant to increase shelf life of meat products. Previous studies have shown the effectiveness of natural plant extracts reducing lipid oxidation in cooked beef links from cattle fed distillers grains (2015 Nebraska Beef Cattle Report, pp. 122–123) but have none have investigated the impacts in raw ground beef. Therefore, the objective of this study was to evaluate the impact of feeding dried de-oiled distillers grains during the finishing phase on raw and cooked ground beef and determine the impact of added antioxidants on shelf life of raw ground beef.

Procedure

Cattle (n = 96) were randomly assigned to one of two finishing diets; corn (control) or dried, deoiled distillers grains (DDDG, 50% DM Basis). Cattle were harvested at a commercial abattoir. Forty-eight h postharvest, 7 USDA Choice beef shoulder clods from each dietary treatment group were collected from the right side of carcasses and vacuum packaged. On d 14 postmortem, lean, subcutaneous fat, and ground composite samples were collected from each shoulder clod for fatty acid composition and proximate composition. Each shoulder clod was independently ground. Twelve 0z patties (hand operated hamburger press) per shoulder clod were overwrapped with permeable oxygen wrap and placed under simulated retail display for 7 d. Six patties contained 0.2% cherry, rosemary, and green tea natural plant extract (ARGT 101 Dry, Kemin Industries, Des Moines, IA) and six had no added antioxidant. During retail display, percent discoloration (7 person panel) and objective color (L* a* b*) were evaluated on d 0, 1, 2, 3, 4, 5, 6, and 7. Samples under retail display were collected at d 0, 1, 2, 3, 5 and 7 for thiobarbituric acid reactive substances (TBARS) analysis.

For the cooked portion of the study, a 5 lb sample from each shoulder clod and non-meat ingredients (0.75% salt, 0.25% phosphate) were mixed for 1 min and...
stuff ed into skinless links using a piston
stuff er. Links were placed in foil trays
and cooked to an internal temperature of
160 °F. Links were placed in zip- top bags
and placed in dark refrigerated storage.
Lipid oxidation was evaluated on d 0, 3,
6, 9, 12, 15, and 18 of refrigerated storage
for TBARS analysis. Data were analyzed
by treatment (diet for cooked links and
diet, antioxidant, and diet × antioxidant
interaction for raw patties) with repeated
measures (day) utilizing the PROC GLIM-
MIX procedures of SAS.

Results
For raw patty TBARS, there was an
antioxidant × day interaction \((P \leq 0.001;\)
Figure 1), patties with antioxidant addition
had lower TBARS concentrations on d 2, 3,
5 and 7 \((P \leq 0.001)\) than patties with no an-
tioxidant inclusion. No dietary effects were
observed \((P = 0.925)\). Percent discoloration
had an antioxidant × diet × day interaction
\((P = 0.008; \text{ Figure 2})\) where patties with an-
tioxidant had less discoloration than those
without antioxidant. Patties from cattle fed
DDDG had greater discoloration when no
antioxidants were added. An antioxidant
× diet × day interaction \((P = 0.036)\) was
observed for a* (redness; Table 1). Patties
with antioxidant had higher a* values than
those without antioxidant, and patties with
no antioxidant inclusion from cattle fed
DDDG had lower a* values than patties
from cattle fed corn on day 4 and beyond.
Patties from treatments that retained great-
er redness also had less discoloration. For
b* values (yellowness), main eff ects were
observed for both antioxidant and time
\((P = 0.009 \text{ and } 0.017, \text{ respectively; data not}
shown), where b* values linearly decreased
over time. The inclusion of antioxidants
resulted in patties with greater b* values.
For fatty acid composition (Table 2),
C18:2 was signifi cantly greater in compos-
ite and fat samples from DDDG than the
corn control \((P < 0.0001)\). Additionally,
cattle fi nished on DDDG had higher poly-
unsaturated fatty acids (PUFA) than cattle
fi nished on corn in composite samples \((P =
0.043)\). For lipid oxidation in cooked links,
a treatment × day interaction was observed
\((P = 0.007; \text{ Figure 3}), \text{ where cattle fed}
DDDG had greater TBARS concentrations
on d 9, 12 and 18 \((P = 0.042, 0.013 \text{ and}
< 0.0001, \text{ respectively}), \text{ with a tendency to

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Table 1. Effects of feeding deoiled distillers grain (DDDG) during fi nishing and adding antioxidants,
rosemary, green tea, and cherry natural plant extract, to ground beef on redness (a*) of raw
beef patties during retail display.

<table>
<thead>
<tr>
<th>Day</th>
<th>Diet</th>
<th>Corn</th>
<th>DDDG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>26.09a</td>
<td>26.39a</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>22.00ab</td>
<td>21.25bcde</td>
</tr>
<tr>
<td>2</td>
<td></td>
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<td>21.09abcde</td>
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<tr>
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</tr>
<tr>
<td>4</td>
<td></td>
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<td>17.54a</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>20.47abcde</td>
<td>15.04a</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>19.79bcd</td>
<td>12.51bcde</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>17.88bcde</td>
<td>9.59b</td>
</tr>
</tbody>
</table>

\*Means within the table lacking a common superscript are signifi cantly diff erent \((P \leq 0.05)\)

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Figure 2. Effect of dried de-oiled distillers grains (DDDG) inclusion (0% or 50% DM basis) and the
addition of antioxidant (0.0 or 0.2% added rosemary, green tea, and cherry natural plant extract) on the
percent discoloration in raw ground beef patties throughout simulated retail display. SE=4.47

Figure 3. Effect of fi nishing diet of dried de-oiled distillers grain (DDDG, 50% DM Basis) or corn (0%
DDDG) on lipid oxidation (mg of malonaldehyde/kg of sample) in cooked beef links throughout refriger-
ated storage. SE=0.54

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have greater TBARS values on d 15 ($P = 0.055$). Therefore, raw patties from cattle finished on DDDG were more discolored over time than patties from cattle finished on corn, and the addition of antioxidants masked any dietary effects. Cooked links from cattle finished on DDDG were more oxidized with extended refrigerated storage than links from cattle finished on corn. Moreover, subcutaneous fat and composite samples from cattle finished on DDDG had higher concentrations of C18:2.

Feeding deoiled distillers grain during finishing resulted raw ground beef that was more discolored and less red and cooked ground beef links with greater lipid oxidation. The addition of antioxidant, rosemary, green tea, and cherry natural plant extract, resulted in in raw ground with improved color stability and less lipid oxidation.

**Acknowledgement**

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Brandy D. Cleveland, graduate student
Tommi F. Jones, research technician
James C. MacDonald, associate professor
Gary A. Sullivan, assistant professor, Animal Science, Lincoln

<table>
<thead>
<tr>
<th>Table 2. Effect of feeding dried de-oiled distillers grains on fatty acid composition (mg/100g raw sample) on shoulder clod composite, lean and subcutaneous fat samples</th>
<th>Composite</th>
<th>Corn</th>
<th>DDDG</th>
<th>P value</th>
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<tr>
<td>C15:0 (mg/100g)</td>
<td>110.3f</td>
<td>84.7s</td>
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<td>C16:1 (mg/100g)</td>
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<td>C18:1T (mg/100g)</td>
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<td>C20:2 (mg/100g)</td>
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<td>PUFAa (mg/100g)</td>
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<tr>
<td>Fat</td>
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<tr>
<td>C15:0 (mg/100g)</td>
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<td>452.0f</td>
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<td>3883f</td>
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<td>816.5f</td>
<td></td>
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<td>C22:0 (mg/100g)</td>
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<td>84.1f</td>
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<td>79.0f</td>
<td>167.3f</td>
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<tr>
<td>SFAb (mg/100g)</td>
<td>34932</td>
<td>38829</td>
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<td>0.097</td>
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<tr>
<td>UFAa (mg/100g)</td>
<td>63461</td>
<td>59296</td>
<td></td>
<td>0.106</td>
</tr>
</tbody>
</table>

aPolyunsaturated Fatty Acids:
bSaturated Fatty Acids:
cUnsaturated Fatty Acids:
dCorn control diet
eDried De-oiled Distillers Grain Diet
f- gMeans within a row lacking common a superscript are significantly different ($P ≤ 0.05$)