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

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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 in raw and cooked ground beef. The addition of antioxidants to raw ground beef improved color stability regardless of diet.

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 has 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 4 oz 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

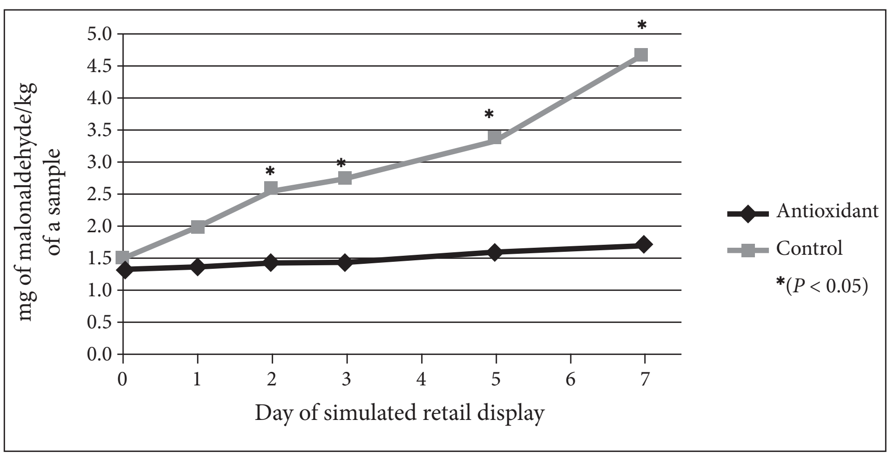

Figure 1. Effect of addition of antioxidant (0.0 or 0.2% added rosemary, green tea, and cherry natural plant extract) on the lipid oxidation (mg of malonaldehyde/kg of sample) in raw ground beef patties throughout simulated retail display. SE=0.22

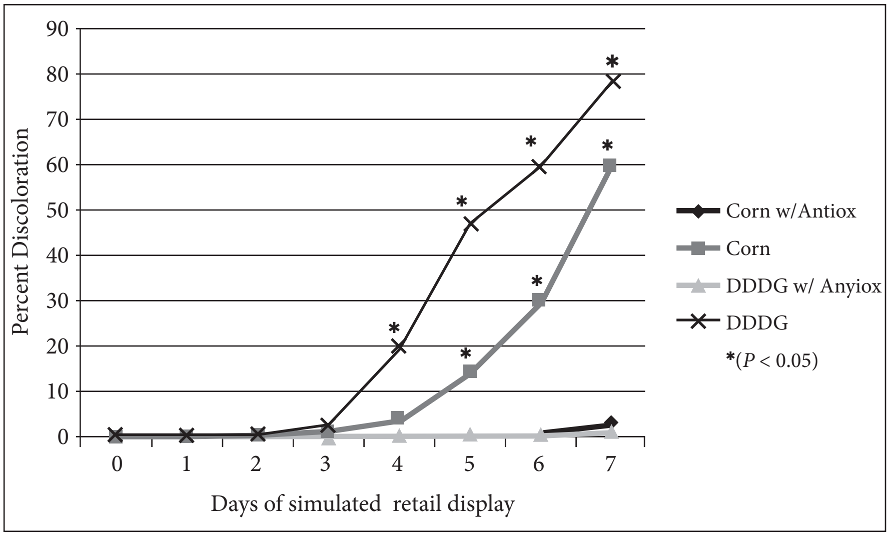

Figure 2. Effect of dried de-oiled distillers grains (DDDG) inclusion (0% or 50% DM basis) and the addition of antioxidant (0.0 or 0.2% added rosemary, green tea, and cherry natural plant extract) on the percent discoloration in raw ground beef patties throughout simulated retail display. SE=4.47

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

Day	Diet			
	Corn		DDDG	
	Antioxidant			
	Yes	No	Yes	No
0	26.09[a]	26.39[a]	25.96[a]	27.70[a]
1	22.00[bc]	21.25[bcde]	21.51[bcd]	22.73[b]
2	21.00[bcde]	21.09[bcde]	21.75[bc]	20.83[cde]
3	21.19[bcde]	19.72[ef]	21.31[bcde]	18.74[fg]
4	20.98[bcde]	17.54[g]	20.64[cde]	15.24[h]
5	20.47[cdef]	15.04[h]	20.28[cdef]	12.30[i]
6	19.79[ef]	12.51[i]	20.09[def]	9.62[j]
7	17.88[g]	9.59[j]	19.01[fg]	7.78[k]

[a-k]Means within the table lacking a common superscript are significantly different ($P \leq 0.05$)

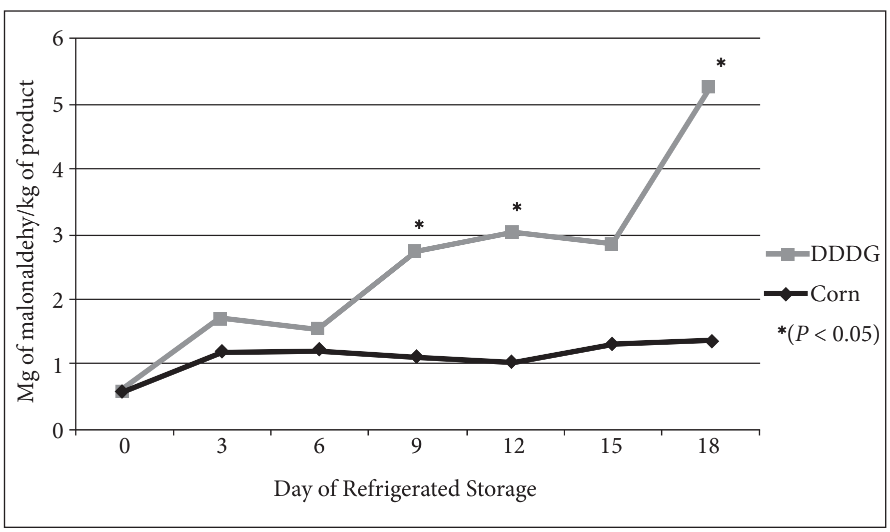

Figure 3. Effect of finishing diet of dried de-oiled distillers grain (DDDG, 50% DM Basis) or corn (0% DDDG) on lipid oxidation (mg of malonaldehyde/kg of sample) in cooked beef links throughout refrigerated storage. SE=0.54

stuffed into skinless links using a piston stuffer. 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 GLIMMIX 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 antioxidant inclusion. No dietary effects were observed ($P = 0.925$). Percent discoloration had an antioxidant × diet × day interaction (P=0.008; Figure 2) where patties with antioxidant 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 greater redness also had less discoloration. For b* values (yellowness), main effects were observed for both antioxidant and time (P= 0.009 and 0.017, 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 significantly greater in composite and fat samples from DDDG than the corn control ($P < 0.0001$). Additionally, cattle finished on DDDG had higher polyunsaturated fatty acids (PUFA) than cattle finished on corn in composite samples ($P = 0.043$). For lipid oxidation in cooked links, a treatment × day interaction was observed ($P = 0.007$; Figure 3), where cattle fed DDDG had greater TBARS concentrations on d 9, 12 and 18 ($P = 0.042$, 0.013 and < 0.0001, respectively), with a tendency to 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.

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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

Composite	Corn[d]	DDDG[e]	P value
C15:0 (mg/100g)	110.3^{f}	84.7^{g}	0.010
C16:1 (mg/100g)	662.6^{f}	522.1^{g}	0.005
C17:0 (mg/100g)	314.4^{f}	210.4^{g}	0.004
C17:1 (mg/100g)	289.2^{f}	160.1^{g}	< 0.001
C18:1T (mg/100g)	391.6^{g}	608.4^{f}	< 0.001
C18:1V (mg/100g)	373.9^{f}	247.6^{g}	0.003
C18:2 (mg/100g)	443.8^{g}	940.9^{f}	< 0.001
C20:2 (mg/100g)	5.9^{g}	12.8^{f}	0.001
C18:3w3 (mg/100g)	20.0^{g}	32.1^{f}	0.006
PUFA[a] (mg/100g)	1521.0^{g}	1929.0^{f}	0.044
Lean	Corn[d]	DDDG[e]	P value
C14:1 (mg/100g)	84.4^{f}	34.1^{g}	0.025
C17:0 (mg/100g)	120.2^{f}	46.0^{g}	0.048
C19:0 (mg/100g)	6.4	5.2	0.100
SFA[b] (mg/100g)	3257	1666	0.087
Fat	Corn[d]	DDDG[e]	P value
C15:0 (mg/100g)	558.5^{f}	452.0^{g}	0.026
C16:1 (mg/100g)	4690^{f}	3503^{g}	0.050
C17:0 (mg/100g)	1365^{f}	1049^{f}	0.061
C17:1 (mg/100g)	1812^{f}	1009^{g}	0.002
C18:0 (mg/100g)	8018^{g}	10348^{f}	0.045
C18:1T (mg/100g)	1777^{g}	3220^{f}	0.001
C18:1V (mg/100g)	2397^{f}	1494^{g}	0.018
C18:2 (mg/100g)	1225^{g}	3883^{f}	< 0.001
C19:0 (mg/100g)	123.0^{g}	193.7^{f}	0.001
C20:1 (mg/100g)	650.8^{g}	816.5^{f}	0.036
C22:0 (mg/100g)	49.5^{g}	84.1^{f}	0.016
C18:3w3 (mg/100g)	79.0^{g}	167.3^{f}	< 0.001
SFA[b] (mg/100g)	34932	38829	0.097
UFA[c] (mg/100g)	63461	59296	0.106

[a]Polyunsaturated Fatty Acids:
[b]Saturated Fatty Acids:
[c]Unsaturated Fatty Acids:
[d]Corn control diet
[e]Dried De-oiled Distillers Grain Diet
[f-g]Means within a row lacking common a superscript are significantly different ($P \leq 0.05$)