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Effect of feeding distillers grains during different phases of production and addition of postmortem antioxidants on shelf life of ground beef[1]

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ABSTRACT

Feeding distillers grains (DGS) to cattle can increase PUFA concentration, increase lipid oxidation, and decrease color stability of beef. The objective of this study was to evaluate the effects of feeding DGS and the postmortem addition of antioxidants on the shelf life of ground beef products. Crossbred heifers (n = 64; initial BW = 225 kg) were supplemented with different amounts of modified DGS (MDGS; 0.91 or 2.27 kg daily, DM basis) during backgrounding and finished on diets containing corn gluten feed or MDGS. Four beef shoulder clods from each dietary group were ground independently. Fatty acid composition was analyzed in lean tissue, s.c. fat, and composite samples. Raw patties in retail display were analyzed for lipid oxidation, percent discoloration, and objective color. Cooked beef links were manufactured with salt, phosphate, and varying quantities of an antioxidant (rosemary and green tea extract), and lipid oxidation was measured throughout storage. Finishing cattle fed MDGS had greater C18:2 and PUFA ($P \leq 0.028$) content in all locations, whereas cattle supplemented with greater amounts of MDGS during backgrounding had more C18:0 ($P = 0.005$) and less C16:1 ($P = 0.020$) in s.c. fat. Raw ground beef from heifers finished with MDGS discolored at a greater rate ($P < 0.001$), but lipid oxidation was not different ($P = 0.47$). Greater lipid oxidation in cooked beef links occurred when cattle were fed greater amounts of MDGS during backgrounding or MDGS during finishing, but adding the rosemary and green tea extract decreased lipid oxidation regardless of dietary treatment.

Key words: distillers grains, fatty acid composition, ground beef, lipid oxidation, rosemary and green tea extract

INTRODUCTION

In 2013, 35.5 million metric tons of distillers grains (**DGS**) was produced as coproducts of the fuel ethanol industry, and beef cattle account for almost half of DGS consumption (Renewable Fuel Association, 2016). Researchers have reported that steaks from cattle fed wet DGS (**WDGS**) have a greater PUFA concentration and less oxidative stability (Jenschke et al., 2008; Depenbusch et al., 2009) and that feeding WDGS can increase lipid oxidation in ground beef (Koger et al., 2010) compared with beef from cattle not fed DGS.

Lipid oxidation occurs most readily in PUFA and is associated with rancidity or warmed-over flavors in beef. The free radicals formed from lipid oxidation can increase myoglobin oxidation (Liu et al., 1995), and likewise, myoglobin oxidation can promote lipid oxidation (Faustman et al., 2010). Comminuting meat increases lipid oxidation by disrupting the phospholipid membranes and allowing for greater exposure to oxygen (Sato and Hegarty, 1971). Cooking meat increases lipid oxidation by the release of free- and heme-iron from myoglobin (Greene and Cumuze, 1982). Much research has been conducted on feeding DGS in finishing diets to cattle on raw steak and ground beef characteristics (Jenschke et al., 2008; Depenbusch et al., 2009; Koger et al., 2010); however, few have investigated the effect of supplementation with DGS during backgrounding (Buttrey et al., 2012). Dierks et al. (2017) reported that supplementation of dried DGS (**DDGS**) during backgrounding resulted in greater lipid oxidation of cooked beef patties than nonsupplemented cattle. Dierks et al. (2017) also reported an unexpected reduction in lipid oxidation in cooked beef patties from cattle finished with WDGS than when no WDGS was fed. They suggested the inclusion of different fat depots and the cooking process of cooked ground beef links were possible explanations.

The use of plant extracts such as rosemary or green tea as natural antioxidants is common in meat processing. Both rosemary and green tea have phenolic compounds that donate the phenolic hydrogen to quench free radicals formed during lipid oxidation (Tang et al., 2001).

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Table 1. Finishing diet composition (% of diet DM basis)

Item, %	CCGF	MDGS
High-moisture corn	50.0	50.0
CCGF[1]	40.0	—
MDGS[2]	—	40.0
Wheat straw	5.0	5.0
Supplement	5.0	5.0
Supplement composition, % of diet DM		
Fine-ground corn	2.7650	2.7650
Limestone	1.7150	1.7150
Salt	0.3000	0.3000
Tallow	0.1300	0.1300
Beef trace mineral[3]	0.0500	0.0500
Rumensin-90[4]	0.0167	0.0167
Tylan-40[5]	0.0083	0.0083
Vitamin A-D-E[6]	0.0150	0.0150
Analyzed nutrient composition, % DM basis		
CP	15.0	18.4
Fat	4.25	7.01
NDF	19.7	23.3

[1]CCGF = commercial corn gluten feed (Sweet Bran, Cargill Corn Milling, Blair, NE); contained 4.49% fat; fatty acid composition: C16:0 = 21.18%, C18:0 = 3.99%, C18:1 = 25.91%, C18:2 = 46.24%, C18:3 = 2.69%.

[2]MDGS = modified distillers grains with solubles; contained 11.39% fat; fatty acid composition: C16:0 = 14.92%, C18:0 = 2.12%, C18:1 = 27.57%, C18:2 = 53.21%, C18:3 = 1.70%, C20:5 0.16%, C24:0 = 0.31%.

[3]Premix contained 6% Zn as ZnO, 5% Fe as $FeSO_4$, 4% Mn as MnO, 2% Cu as $CuSO_4$, 0.28% Mg, 0.2% I as $Ca(IO_3)_2(H_2O)$, and 0.05% Co as $CoCO_3$.

[4]Premix contained 198 g/kg monensin (Rumensin, Elanco Animal Health, Indianapolis, IN).

[5]Premix contained 88 g/kg tylosin (Tylan, Elanco Animal Health).

[6]Premix contained 29,974 IU/g vitamin A, 5,995 IU/g vitamin D, and 7.5 IU/g vitamin E.

Therefore, the objectives of this trial were to evaluate the effect of feeding different concentrations of modified DGS (**MDGS**) during winter backgrounding and either MDGS or commercial corn gluten feed (**CCGF**; Sweet Bran, Cargill Corn Milling, Blair, NE) during the finishing phase on raw and cooked ground beef and to evaluate the effectiveness of natural rosemary and green tea extract in the cooked beef samples to counteract differences in lipid oxidation due to animal diet.

MATERIALS AND METHODS

Dietary Treatments and Product Collection

All animal protocols performed in this study were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee (Protocol # 902). Spayed crossbred heifers (n = 64; initial BW = 225 ± 2 kg) were randomly assigned to a 2 × 2 factorial arrangement of dietary treatments that included backgrounding supplementation amount (0.91 or 2.27 kg of MDGS daily; 146 d) while grazing on corn stalks and finishing diet (corn-based diet with either CCGF or MDGS at 40% diet DM; 134 d; Table 1). Cattle were grazed on corn stalks as a single unit within treatment. Both finishing diets contained 33 mg/kg monensin (Rumensin, Elanco Animal Health, Indianapolis, IN), and tylosin was provided at 90 mg/heifer daily (Tylan, Elanco Animal Health). Two pens of 8 head were replicated per dietary treatment combination. All cattle were supplemented with DDGS plus solubles at a rate of 0.6% of BW during the summer months (111 d) while grazing on native range grass. The native range grass composition is described in experiment 2 of the study by Buckner et al. (2013). A deferred rotational grazing system was used, as described by Schacht et al. (2011), and stocked at 2.08 animal unit months/ha.

At the time of receiving and before winter backgrounding, heifers were vaccinated against *Clostridium chauvoei*; *Clostridium septicum*; *Clostridium novyi*; *Clostridium sordellii*; *Clostridium perfringens* Types B, C, and D; and *Histophilus somni* (BoviShield Gold, Ultrabac 7/Somubac, Zoetis Inc., Kalamazoo, MI) and *Mannheimia haemolytica* type A1(One Shot *Pasteurella*, Zoetis Inc.). Heifers also received an injectable parasiticide for control of gastrointestinal roundworms, lungworms, eyeworms, grubs, suck-