Impact of Dietary Fat Source on Beef Display Life

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Summary with Implications

This study was conducted to evaluate the effects of dietary fat source with modified distillers grains plus solubles (MDGS) on beef display life. Steers were fed either a corn control, full-fat MDGS, de-oiled MDGS, or de-oiled MDGS plus corn oil diet. Strip loins were aged for 2, 9, 16 and 23 days and placed under retail conditions for 7 days. Results suggest that feeding MDGS to cattle increases polyunsaturated fatty acid content of beef and has the potential to reduce beef color and lipid stability in comparison to corn diets. These data indicate that feeding MDGS to cattle may decrease beef display life. Addition of corn oil to de-oiled MDGS decreased redness and increased discoloration and lipid oxidation in comparison to corn control diets.

Introduction

Byproducts of ethanol fuel production from corn have provided greater amounts of distillers grains for cattle feeding in Nebraska. Feeding distillers grains to cattle increases the concentration of polyunsaturated fatty acids (PUFA) in meat and consequently, can increase lipid and myoglobin oxidation. Increased lipid and myoglobin oxidation, can lead to off-flavor development and discoloration of beef, resulting in reduced display shelf life. As ethanol plants look for ways to extract more value from distillers grains, the feed value of the byproduct is changing. Improved extraction technologies in the ethanol industry have allowed for the increased removal of corn oil from distillers grains with solubles, reducing its fat content. There is an interest in adding the oil back to de-oiled MDGS when economically feasible. However, the effects of adding corn oil to de-oiled modified distillers grains plus solubles (MDGS) on beef display life are still unknown. A deeper insight of the effects of the corn oil addition could help improve beef shelf-life and the way cattle are fed in Nebraska. Therefore, this study was conducted to determine the effect of feeding different dietary fat sources with MDGS on beef display life.

Procedure

A total of 256 steers were allocated in 32 pens (8 head/pen) and fed for 134 d on either a corn control, 40% full-fat MDGS, 40% de-oiled MDGS, or 38% de-oiled MDGS plus 2% corn oil diet. Strip loins from 24 USDA Choice carcasses (3head/pen) were randomly selected within each dietary treatment and strip loins from both sides were collected. Then, both loins per animal were divided in half, and each of the four sections was randomly assigned to one of the four aging periods (2, 9, 16, or 23 d).. After aging (1°C), loins sections were trimmed of subcutaneous fat, and fabricated into three steaks (2.54 cm thickness) for fatty acid profile, objective color, visual discoloration, and lipid oxidation [1 steak for objective color and discoloration, 1 steak was split in half for fatty acid profile and lipid oxidation for 0 d retail display (RD), 1 steak was split in half for 4 and 7 d RD lipid oxidation]. After fabrication, steaks used for color analysis and lipid oxidation were placed on foam trays, overwrapped with oxygen permeable film and placed under retail display conditions for 7 d at 3°C. The same fabrication scheme was used at 9, 16 and 23 d postmortem, with the exception of fatty acids profile, which was analyzed only at d 2 postmortem.

Fatty acid profile

One g of powered strip loin steak with no subcutaneous fat was analyzed using gas chromatography. Fatty acids were separated using a Chrompack CP-Sil 88 capillary column and identified by their retention times in relation to known commercial standards. The percentage of fatty acids was determined by the peak areas in the chromatograph. Then, values were adjusted according to percent fat in the tissue and converted to mg/100 g tissue.

Lipid oxidation (TBARS)

Thiobarbituric acid reactive substance values (TBARS) were measured for all aging periods at 0, 4 and 7 d of display. Five g of powdered strip loin steak with no subcutaneous fat was used to conduct the TBARS protocol. Results were expressed in mg of malonaldehyde per kg of muscle tissue.

Color measurements

Objective color was measured daily during retail display for 7 d with a Minolta Colorimeter (CR-400, Minolta Camera Company, Osaka, Japan). Color measures were obtained by averaging 6 readings from different areas of the steak surface. The CIE L^*, a^*, and b^* values correspond to lightness, redness and yellowness, respectively. Visual discoloration was evaluated daily by a panel of 5 trained panelists using a percentage scale where 0% meant no discoloration and 100% meant complete surface discoloration.

Statistical Analysis

Fatty acid profile was analyzed as a completely randomized design. The TBARS data were analyzed as a split-split plot design with dietary treatment as the whole-plot, aging period as the split-plot and d of retail display as the split-split plot. Color data were analyzed as a split-split-plot

Table 1. Amount[1] of fatty acids of strip steaks from steers fed different dietary fat sources

Fatty Acids	Corn control	Full-fat MDGS	De-oiled MDGS	De-oiled MDGS plus oil	*P*-value
C14:0	251.39	242.10	254.82	287.61	0.37
C14:1	70.61	65.31	70.99	75.81	0.74
C15:0	40.46	32.71	32.23	41.27	0.13
C15:1	115.99	134.60	87.21	87.10	0.14
C16:0	1,828.81	1,715.34	1,868.53	2,036.37	0.14
C16:1	236.26	220.69	242.30	250.14	0.70
C17:0	81.61	66.41	61.75	68.97	0.13
C17:1	67.11	61.92	75.92	79.04	0.42
C18:0	866.32[b]	959.24[ab]	946.22[ab]	1,100.07[a]	0.03
C18:1T	10.23	22.44	23.77	23.93	0.07
C18:1	2,246.00	2,239.05	2,229.08	2,526.04	0.22
C18:1V	135.10	138.50	122.14	158.95	0.07
C18:2	406.61[b]	549.63[a]	555.86[a]	565.64[a]	< 0.01
C18:3	13.59[b]	15.99[ab]	14.05[ab]	17.97[a]	0.03
C20:4	104.38	96.61	98.82	91.22	0.72
Total	6,636.93	6,685.73	6,830.98	7,649.30	0.12
SFA	3,139.77	3,078.83	3,242.20	3,627.84	0.10
UFA	3,497.11	3,615.12	3,588.74	4,021.49	0.16
MUFA	2,913.50	2,885.56	2,856.90	3,627.82	0.18
PUFA	577.41[b]	729.68[a]	731.75[a]	751.96[a]	0.01

[1]Amount of fatty acid expressed in mg/100 g of tissue.
[a,b] Means in the same row with different superscripts differ ($P \leq 0.05$).

Table 2. Lipid oxidation value (TBARS; mg malonaldehyde /kg of meat) of strip loin steaks (*longissimus lumborum)* from steers fed either a corn diet, 40% Full-fat MDGS, 40% De-oiled MDGS or 38% De-oiled MDGS plus 2% corn oil with 0, 4 and 7 d retail display.

Dietary Treatment	Days on retail display		
	0	4	7
De-oiled MDGS	0.72[a]	2.44[a]	4.94[a]
Full-fat MDGS	0.75[a]	2.16[a]	4.45[ab]
De-oiled MDGS plus corn oil	0.76[a]	2.43[a]	4.90[a]
Corn control	0.75[a]	2.07[a]	3.98[b]

[a-c] Means in the same column with different superscripts are different ($P < 0.05$)

repeated measures design with retail display as the repeated measure. Pen was used as experimental unit and data were analyzed using the PROC GLIMMIX procedure of SAS with the LS MEANS statement and TUKEY adjustment. Statistical significance was determined at $P < 0.05$ and tendencies were considered at $P < 0.10$.

Results

Dietary treatments altered the amount of stearic acid (C18:0), linoleic acid (C18:2), α-linolenic acid (C18:3) and PUFA of beef (Table 1). Beef from cattle fed de-oiled MDGS plus oil had the greatest amount of C18:0 ($P = 0.03$) in comparison with all other dietary treatments. However, samples from cattle fed corn control, full-fat MDGS and de-oiled MDGS were not different from each other. The C18:2 ($P < 0.01$) and PUFA ($P = 0.01$) were found to be greater in cattle fed any source of MDGS, and lowest for cattle fed corn control. The C18:3 ($P = 0.03$) content was least for cattle fed corn control, greatest for the de-oiled MDGS plus oil, and intermediate for cattle fed full-fat MDGS and de-oiled MDGS. Typically, increased PUFA content leads to increased lipid oxidation, thus reducing beef shelf life.

A significant interaction between dietary treatment and RD was observed for lipid oxidation ($P < 0.01$). No differences in lipid oxidation were found among dietary treatments at 0 and 4 d of RD. Beef from cattle fed corn control tended to have lower lipid oxidation ($P < 0.10$) when compared with de-oiled MDGS and de-oiled MDGS plus oil (3.90 vs 4.94 and 4.90 mg malonaldehyde/kg of meat, respectively) at d 7 of RD. Cattle fed full fat MDGS had intermediate TBARS values (4.45 mg malonaldehyde/kg of meat) and did not differ from any other dietary treatment at d 7 of RD (Table 2). A two-way interaction between aging and RD for lipid oxidation was found ($P < 0.01$). As expected, lipid oxidation measured via TBARS increased as aging and retail display progressed.

The L* and b* values were not different among dietary treatments. A two-way interaction between RD and dietary treatment was found for a* values ($P < 0.01$). There were no differences from days 0 to 4 of RD for a* values among dietary treatments. Lower a* values (less red) were found for beef from cattle fed de-oiled MDGS in comparison to all other dietary treatments (17.04 vs 17.91 for de-oiled MDGS plus oil, and 18.13 for corn control, and 18.15 for full fat MDGS) at d 5 of RD. Steaks from steers fed corn control had greater a* values (more red) than steaks from cattle fed de-oiled MDGS and de-oiled MDGS plus oil (16.20 vs 14.54 and 15.22, respectively) at d 6 of RD. Greater a* values were found for beef from cattle fed corn control in comparison to beef from cattle fed de-oiled MDGS and de-oiled MDGS plus oil (13.79 vs 12.33 and 12.48, respectively) at d 7 of RD. Beef from cattle fed full-fat MDGS tended to have lower a* values ($P < 0.10$) than cattle fed corn control at d 7 of RD (13.05 vs 13.79, respectively). In general, as retail display progressed, beef from cattle fed corn control was more red than beef from cattle MDGS. Interactions between aging and RD time were detected for all three objective color measures ($P < 0.01$). As expected, L* values increased and a* and b* values decreased as aging and retail display time increased.

A two-way interaction between dietary treatment and RD for discoloration was found ($P = 0.0006$). Surface discoloration scores of strip loin steaks at prolonged retail display are presented in Table 3. There were no differences on days 0 to 4 of RD for discoloration scores among dietary treatments. At d 5 of RD, beef from cattle fed de-oiled MDGS had greater discoloration than beef from any other dietary treatment. Greater

Table 3. Discoloration (%) of strip loin steaks (L. dorsi) at days 5, 6 & 7 retail display

Dietary Treatment	Days on retail display		
	5	6	7
De-oiled MDGS	14.63[a]	41.32[a]	65.16[a]
Full-fat MDGS	7.13[b]	35.85[ab]	58.08[b]
De-oiled MDGS plus corn oil	7.99[b]	33.76[b]	58.64[b]
Corn control	5.70[b]	31.39[b]	49.82[c]

[a-c] Means in the same column with different superscripts are different ($P < 0.05$)

discoloration was found for beef from cattle fed de-oiled MDGS when compared to beef from cattle fed de-oiled MDGS plus oil and corn at d 6 of RD. However, cattle fed-full fat MDGS had intermediate discoloration scores at d 6 of RD and did not differ from any other dietary treatment. Discoloration scores were least for cattle fed corn control, intermediate for cattle fed full-fat MDGS and de-oiled MDGS plus oil, and greatest for the de-oiled MDGS at d 7 of RD. As retail display progressed, discoloration progressed at slower rates in beef from cattle fed corn control. A two-way interaction between aging time and RD for discoloration was observed ($P < 0.01$). Discoloration increased as RD time increased, regardless the dietary fat source at all aging periods.

Conclusion

Results suggest that feeding MDGS to cattle has the potential to reduce color and lipid stability compared to corn control diet and thus reduce beef shelf life. Addition of corn oil to de-oiled MDGS decreased redness and increased discoloration and lipid oxidation in comparison to corn control diets.

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