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Impact of Dietary Fat Source on Beef Tenderness

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Summary with Implications

Steers were finished on either a corn control, 40% full-fat modified distillers grains plus solubles, 40% de-oiled modified distillers grains plus solubles, or 38% de-oiled modified distillers grains plus solubles plus 2% corn oil diet to evaluate the effects of dietary fat source on the mechanism of beef tenderization . Feeding modified distillers grains plus solubles increased polyunsaturated fatty acid content in the sarcoplasmic reticulum membrane and increased free Ca^{2+} concentration early postmortem. Steaks from cattle fed de-oiled modified distillers grains and de-oiled modified distillers grains plus corn oil were more tender at 2 d of aging when compared to corn control diet. These data indicate that feeding modified distillers grains plus solubles to cattle has the potential to increase beef tenderness early postmortem in comparison to corn diets.

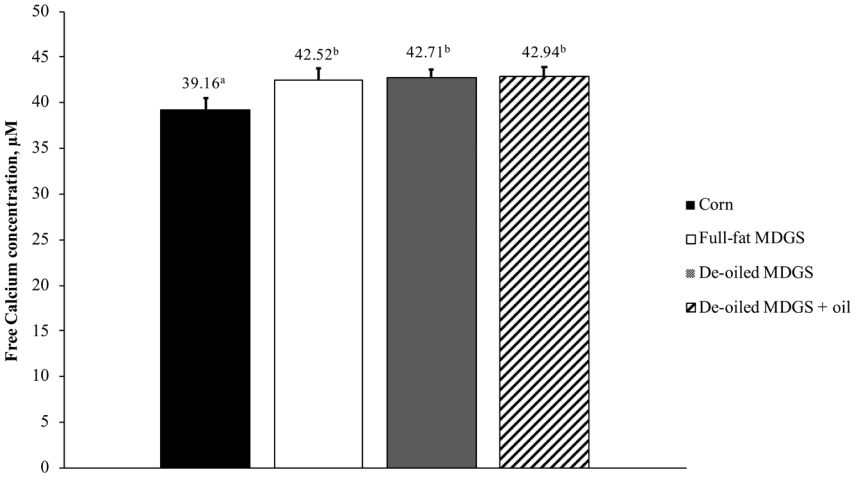

Figure 1. Free calcium concentration of strip loins steaks aged for 2 d from steers fed either a corn diet, 40% Full-fat modified distillers grains plus solubles (MDGS), 40% De-oiled MDGS or 38% De-oiled MDGS plus 2% corn oil. [a-b] Different superscripts indicate differences ($P = 0.05$).

Introduction

Research evaluating the impact of distillers grains on beef tenderness has provided conflicting results. Recent studies conducted at the University of Nebraska suggest that beef from steers fed wet distillers grains plus solubles can be more tender earlier postmortem than beef from steers fed the corn control diet. The hypothesis is that elevated concentrations of polyunsaturated fatty acids (PUFA) in the sarcoplasmic reticulum (SR) membrane may cause the SR membrane to rapidly lose integrity due to increased oxidation potential, leading to early postmortem release of previously sequestered Ca^{2+}. This released free Ca^{2+} potentially could interact with calpains and accelerate early postmortem protein degradation, making meat more tender. Therefore, this study was conducted to determine the effect of feeding different dietary fat sources with modified distillers grains plus solubles (MDGS) on the beef tenderization mechanism.

Procedure

A total of 256 steers were allocated in 32 pens (8 hd/pen) and fed for 134 d on either a corn control, 40% full-fat MDGS (dry matter basis), 40% de-oiled MDGS, or 38% de-oiled MDGS plus 2% corn oil diet. Strip loins from 24 USDA Choice carcasses (3 hd/pen) were randomly selected within each dietary treatment and strip loins from both sides were collected. Then, both loins per carcass were divided in half, and each of the four loin sections were randomly assigned to one of the four aging periods (2, 9, 16, or 23 d). On d 2 of aging, loin sections were trimmed of subcutaneous fat, and fabricated into two steaks and utilized to determine sarcomere length, troponin-T degradation, fatty acid profile of the SR membrane, free Ca^{2+} concentration, and tenderness [1 steak for tenderness (1 in thickness) and 1 steak (0.5 in thickness) for all other analysis]. Loin sections aged for 9, 16, and 23 d were analyzed only for tenderness. Tenderness was measured via Warner-Bratzler shear force (WBSF) method, sarcomere length was measured via laser diffraction, SR membrane fatty acids were analyzed via gas chromatography, free Ca^{2+}concentration was analyzed via inductively coupled plasma spectroscopy, and troponin-T degradation was analyzed via immunoblotting. Tenderness data were analyzed as a split-plot design with dietary fat source as the whole-plot and aging period as the split-plot. All other variables evaluated at d 2 postmortem were analyzed as a completely randomized design. Pen was considered the experimental unit and data were analyzed using the PROC GLIMMIX procedure of SAS. All means were separated with the LS MEANS and DIFF functions ($\alpha = 0.05$). Tendencies were considered at $P < 0.10$.

Results

Results for the SR membrane fatty acid profile are presented in Table 1. Feeding

Table 1. Fatty acid profile (%) of sarcoplasmic reticulum membrane from strip loins from steers fed either a corn diet, 40% Full-fat modified distillers grains plus solubles (MDGS), 40% De-oiled MDGS or 38% De-oiled MDGS plus 2% corn oil.

	Dietary Treatment					
Fatty Acids, %	Corn	Full-fat MDGS	De-oiled MDGS	De-oiled MDGS + oil	SEM	*P*-value
C14:0	0.64	0.59	0.55	0.71	0.24	0.92
C15:0	0.52	0.54	0.29	0.22	0.17	0.30
C15:1	2.15	1.78	2.02	1.68	0.20	0.33
C16:0	17.73	17.84	17.23	17.89	1.01	0.97
C16:1	1.11	1.04	1.10	1.09	0.13	0.93
C17:0	0.85	0.65	0.63	0.62	0.10	0.16
C17:1	0.70	0.72	0.44	0.52	0.12	0.39
C18:0	14.87	12.97	13.22	13.84	0.61	0.20
C18:1	22.70	21.40	21.31	21.91	1.14	0.80
C18:1V	2.43[a]	1.91[b]	2.02[b]	2.10[ab]	0.10	< 0.01
C18:2	17.63[b]	24.51[a]	23.37[a]	23.03[a]	1.27	< 0.01
C18:3	0.67	0.41	0.66	0.69	0.16	0.61
C20:3	2.14	1.68	1.85	1.77	0.18	0.28
C20:4	8.37	8.04	8.20	7.35	0.60	0.71
C22:4	0.92	0.71	0.94	0.85	0.10	0.24
C22:5	1.81	1.55	1.59	1.62	0.13	0.77
SFA	35.18	32.09	31.95	33.48	1.45	0.62
MUFA	28.97	27.45	27.57	28.28	1.19	0.41
PUFA	31.26[b]	36.85[a]	36.46[a]	37.25[a]	1.70	0.06
Fat	6.67	6.78	6.84	7.55	0.33	0.34

Note: SFA = saturated fatty acids, MUFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids, and Fat = fat content of the meat (%). [a-b] Different superscripts within the same row indicate differences ($P < 0.05$). P values between 0.05 and 0.10 were considered as trends.

MDGS decreased ($P < 0.05$) concentrations of 18:1V, increased ($P < 0.05$) concentrations of linoleic acid (18:2) and tended to increase ($P = 0.06$) total PUFA in the SR membrane. The increase in PUFA content of the SR membrane supports the hypothesis that feeding MDGS may alter SR membrane integrity and thus accelerate free Ca^{2+} release.

Free Ca^{2+} values of dietary treatments are presented in Figure 1. Dietary fat source influenced free Ca^{2+} concentration of beef. Steaks from cattle fed MDGS had greater free Ca^{2+} concentrations than steaks from cattle fed corn at d 2 postmortem ($P = 0.05$). Calcium has a major role in meat tenderization as the calpain system requires the presence of Ca^{2+} to be activated. The earlier Ca^{2+} release observed at d 2 postmortem in this project for all MDGS treatments compared to the corn diet supports the hypothesis that feeding high concentrations of distillers grains to cattle could increase free Ca^{2+} available early-postmortem, which could result in improved tenderness.

No differences in sarcomere length among dietary treatments were observed at 2 days postmortem ($P = 0.92$). The average sarcomere length of strip loins from cattle fed corn-only, de-oiled MDGS, de-oiled MDGS plus corn oil and full-fat MDGS were 1.77, 1.76, 1.75 and 1.76 µm, respectively. Sarcomere length has long been recognized as a factor influencing meat tenderness. Relevant changes in sarcomere length begin to occur early postmortem when sarcomeres contract as the muscle goes into rigor. If Ca^{2+} is released when adenosine triphosphate (ATP) is still available, muscle contraction can occur, resulting in detrimental effects on meat tenderness. However, sarcomere length was not compromised in this project, indicating that the earlier release of calcium found in all MDGS treatments likely occurred after the depletion of ATP reserves (completion of rigor mortis).

No differences in troponin-T degradation were found between dietary treatments at 2 d postmortem ($P = 0.60$). The average troponin-T degradation of strip loins from cattle fed corn-only, de-oiled MDGS, de-oiled MDGS plus corn oil and full-fat MDGS were 20.44, 23.85, 22.24 and 24.72%, respectively. It seems that the relationship between troponin-T degradation and improvement in beef tenderness is not linear and that some minimum threshold of degradation is necessary for proteolysis to have any measurable effect on meat tenderness.

Dietary treatment tended to affect WBSF at d 2 postmortem ($P = 0.08$). Compared to steaks from steers fed corn, steaks from steers fed de-oiled MDGS and de-oiled MDGS plus corn oil had lower Warner-Bratzler shear force ($P = 0.03$) at d 2 of aging (Figure 2). Extending aging beyond 2 d mitigated the tenderness effects, as there were no significant differences in tenderness among dietary treatments on samples aged for 9 ($P = 0.38$), 16 ($P = 0.73$) or 23 d ($P = 0.96$). The results from this study suggest that feeding de-oiled MDGS and de-oiled MDGS plus corn oil to cattle

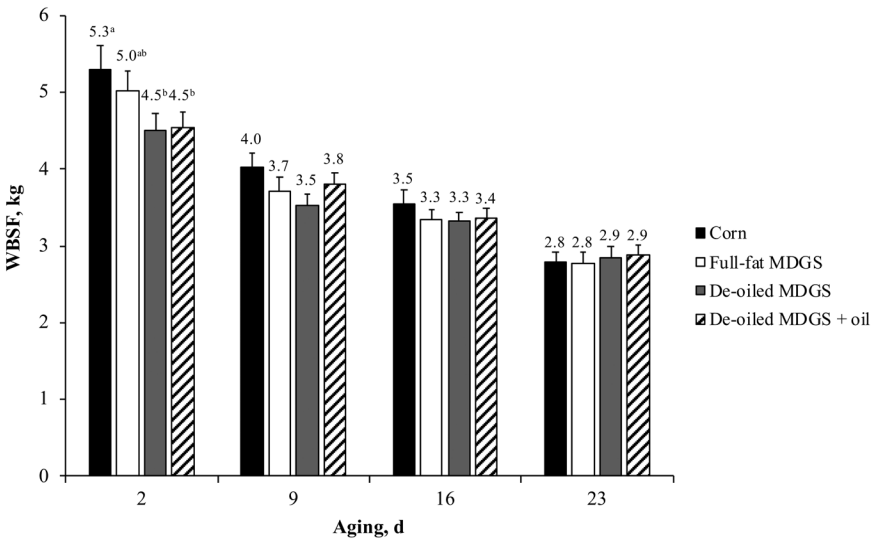

Figure 2. Warner-Bratzler shear force (WBSF) values (kg) of strip loins steaks from steers fed either a corn diet, 40% Full-fat modified distillers grains plus solubles (MDGS), 40% De-oiled MDGS or 38% De-oiled MDGS plus 2% corn oil aged for 2, 9, 16 or 23 days. [a-b] Different superscripts indicate differences ($P < 0.05$).

has the potential to increase early postmortem tenderness, which likely was the result of increased total 18:2 and PUFA in the SR membrane and earlier free Ca^{2+} release.

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