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Low-fat Wet Distillers Grains and Beef Quality

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Summary

A low-fat (4.72%) wet distillers grain (LFWDG) diet was compared to a traditional wet distillers grain with solubles (WDGS) diet and a corn-based diet. All wet distillers diets increased polyunsaturated fatty acids in comparison to the control. The LFWDG diet caused greater oxidative rancidity and had a decreased shelf life; however, there was no change in sensory properties. The LFWDG diet evaluated in this study caused decreased oxidative stability of the muscle compared to the TWDGS and the control diets.

Introduction

Previous studies found inclusion of WDGS in the diet increases the amount of oxidation in beef. Feeding WDGS diets to cattle elevated levels of polyunsaturated fatty acids (PUFA), decreased shelf life, and increased oxidative rancidity (*2009 Nebraska Beef Cattle Report*, pp. 107-109 and 110-112). This occurs because of the fat in WDGS that is not biohydrogenated (saturated) in the rumen. Many ethanol plants are either partially removing oil or evaluating methods to remove oil from the WDGS for other uses than cattle feed. If the amount of oil (fat) in WDGS is reduced, oxidation may be decreased. The hypothesis of this project was feeding low-fat wet DG (LFWDG) would minimize oxidation problems, thereby retaining shelf life of the product.

Procedure

Ninety-six feedlot crossbred yearling steers were allocated to three different finishing diets: LFWDG, traditional wet DG with solubles (TWDGS), and a corn-based diet and were fed for 131 days (*2011 Nebraska Beef Cattle Report* pp. 44-45). The TWDGS diet contained distillers solubles and was 6.91% fat, while the solubles were omitted from the LFWDG diets, which contained 4.72% fat. Forty-five carcasses grading USDA Choice, 15 from each treatment, were randomly selected and their respective strip loins collected, vacuum packaged, and shipped to the Loeffel Meat Laboratory at the University of Nebraska–Lincoln. After aging at 33°F for 12 days post-mortem, the strip loins were fabricated. Seven steaks were cut from the strip loin. Four 1-inch steaks were cut for taste panels and Warner-Bratzler Shear Force (WBSF) testing. The remaining loin sections were cut into ½-inch steaks and oxidation measured with the Thiobarbituric Acid Assay (TBARS) test. Day zero steaks were vacuum packaged and immediately frozen in -20°F freezer.

Day 4 and day 7 steaks were placed into Styrofoam trays and overwrapped with oxygen-permeable film. Steaks were randomly placed into two retail display cases (37 ± 2°F) to simulate retail display conditions. In this simulation, the steaks were exposed to continuous 1,000-1,800 lux warm white fluorescent lighting. At the end of their assigned aging period, steaks were removed from the retail display case and frozen in a -20°F freezer until further testing.

Objective and Subjective Color

Objective color measurements were collected each day for seven days. Using a Minolta Chromameter CR-400 (Minolta Camera Company, Osaka, Japan) with an 8 mm diameter measurement area and a 11 mm diameter illumination area, illuminant D65 and a 2° standard observer, L* (brightness), a* (redness) and b* (blue to yellow) values were recorded. Six different readings were taken from each steak and averaged. Subjective color was also measured every day for seven days in which the score was based upon percent oxidation; 0% indicating no discoloration, 100% indicating discoloration of the entire steak.

Oxidation

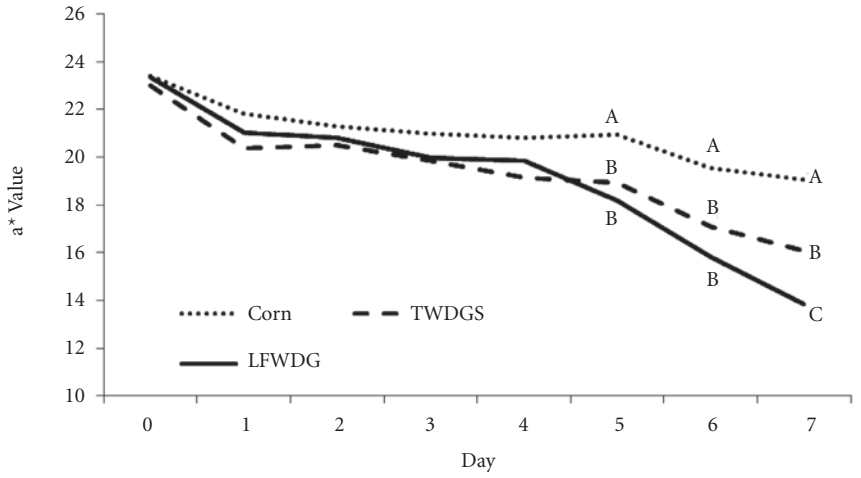
Steaks were removed from freezer storage and cut into small pieces while partially frozen. The pieces were then flash frozen in liquid nitrogen and powdered in a grinder. Powdered samples were then analyzed using the TBARS standard protocol.

Warner-Bratzler Shear Force and Cooking Loss

Steaks for the Warner-Bratzler Shear Force testing were thawed overnight in a cooler and then grilled on Hamilton Beach Indoor/Outdoor grills. Steaks were weighed and the temperature was taken before steaks were placed on the grill and then once again when they reached 160°F. A thermocouple was placed in the geometric center of each steak; this allowed for a more accurate reading of temperature. Steaks were cooked on one side until the center temperature reached 95°F and then turned over until it reached 160°F. The steak was then removed from the grill and weighed. Cooking loss was calculated. Steaks were covered with oxygen-permeable film and placed in a cooler. Twenty-four hours later, the cooked steaks were cored into ½-inch cores and sheared to test Warner-Bratzler Shear Force.

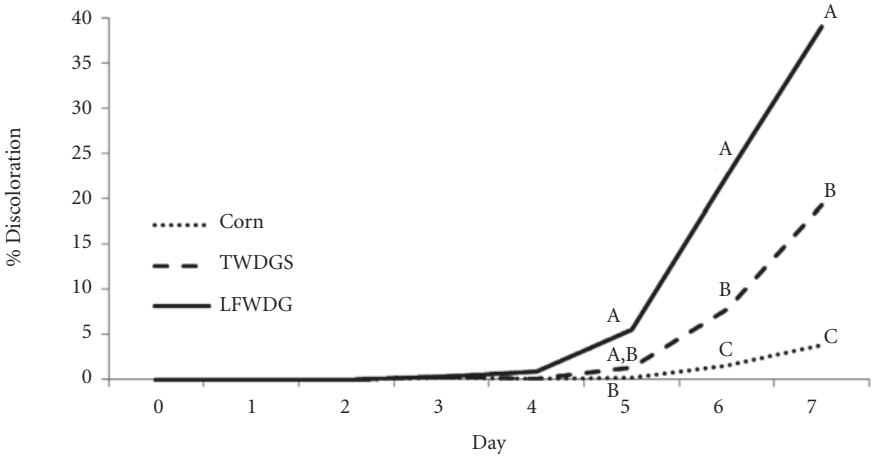
Taste Panel

Steaks from days 0 and 7 of retail display were shipped to the University of Florida for consumer evaluation.



Corn, TWDGS (traditional levels of fat wet distillers grains with solubles), LFWDG (low-fat wet distillers grains).
[A,B,C]Means having different superscripts are different within days of display $P \leq 0.05$.

Figure 1. a* (redness) values for strip loin (M. *longissimus lumborum*) steaks from steers traditional levels of WDGS, low-fat WDG and corn-based diets in retail display.



Corn, TWDGS (traditional levels of fat wet distiller grains with solubles), LFWDG (low-fat wet distiller grains).
[A,B,C]Means having different superscripts are different within days of display $P \leq 0.05$.

Figure 2. Percent discoloration of strip loin (M. longissimus lumborum) steaks from steers traditional levels of WDGS, low-fat WDG, and corn-based diets in retail display.

Prior to cooking, steaks were thawed for 18 hours at 39°F. Steaks were cooked on grated, nonstick electric grills that were preheated for 20 minutes. Steaks were cooked in the same manner as the steaks for the Warner-Bratzler Shear Force testing steaks. Internal temperatures were monitored and placed in the geometric center of each steak. Upon reaching 160°F, steaks were served to 7-11 trained panelists while still warm. Panelists evaluated six samples; two sample cubes that were 1.27 cm^3 per sample, served in warmed, covered containers. Sensory sessions were conducted once or twice daily in a positive pressure ventilated room with lighting and cubicles designed for objective meat sensory analysis. Each sample was evaluated for juiciness (8 = extremely juicy; 1 = extremely dry), flavor (8 = extremely intense beef flavor; 1 = extremely bland beef flavor), tenderness (8 = extremely tender; 1 = extremely tough), connective tissue (8 = none detected; 1 = abundant amount), and off-flavor (1 = extreme off-flavor, 6 = no off-flavor detected). Along with objectively scoring off-flavor, if an off-flavor was noticed, the panelists were asked to describe or characterize the off-flavor to the best of their ability.

Fatty Acid Profile

Gas chromatography was used to determine the fatty acid profile of all the beef samples and the feed samples as well. A Chrompack CP-Sil 88 (0.25 mm x 100 m) was used. Injector temperature was set at 518°F and the detector temperature was set at 572°F. Head pressure was 40 psi and the flow rate was at 1.0 mL/min.

Mineral Analysis

Frozen, powdered meat samples were sent to a commercial laboratory (Ward Laboratories, Inc., Kearney, Neb.) to be tested for mineral composition using atomic adsorption spectroscopy. The amount of Ca, P, K, Mg, Zn, Fe, Mn, Cu, S, and Na. Ca, P, K, Mg, S, and Na was expressed as a percentage of dry matter, while Zn, Fe, Mn, and Cu were reported in ppm on a dry matter basis.

Results

Compared to the other treatments, the objective a* values (redness) of steaks from cattle fed LFWDG declined at a faster rate and to a greater degree (Figure 1). This decline started at day 4 of retail display. Steak discoloration data (Figure 2) correlated strongly with the objective color data. Moreover, the lipid oxidation tests (TBARS) have the same trend (Figure 3). The lipid oxidation values were significantly larger at days 4 and 7 in the LFWDG diet when compared to TWGDS and the corn-based diets.

There were no day by dietary treatment interactions for any attribute ($P > 0.05$). There were day effects for overall tenderness

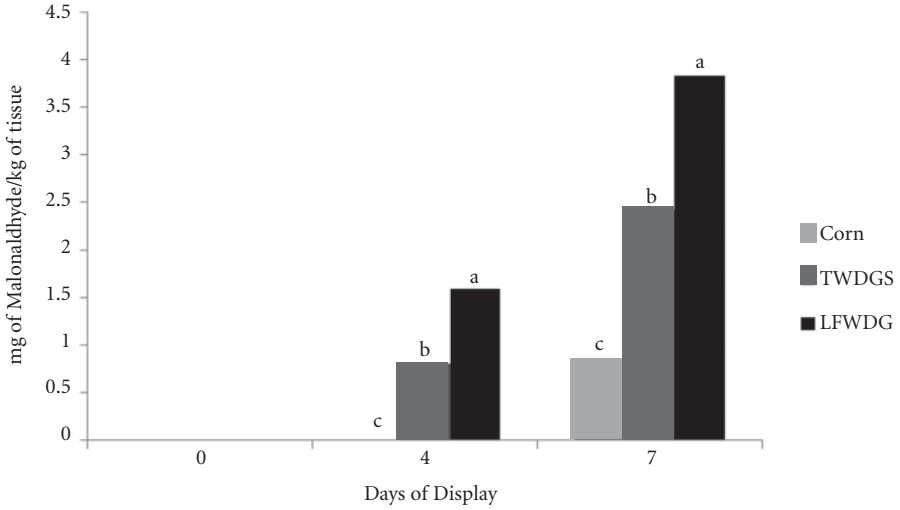
(Continued on next page)

[(<0.0001) 0 day = 5.65 and 7 day = 5.86], connective tissue [(0.0006) 0 day = 6.09 and 7 day = 6.29] and off-flavor [(0.04) 0 day = 5.54 and 7 day = 5.04]. As days of aging increased, tenderness scores increased. Similarly, as days of aging increased, off-flavor was also more apparent. Sensory panels and WBSF test results did not yield many significant differences, and the differences that were present favored the TWDGS diet, which was equal or superior to the control diet (Table 1). There was no significant difference in shear force values among the treatments.

Steaks from cattle fed TWDGS contained significantly more Ca and Na than controls, which likely came from the solubles fraction of the diet (Table 2). In contrast, steaks from cattle fed LFWDG contained less Mn and Cu than the controls. None of these differences would be expected to support greater oxidation of the meat.

The percentages of PUFA and transfatty acids were significantly higher in beef from cattle fed distillers grain-based diets compared to the corn control. Most of the increase in PUFA occurred as a result of increased concentrations of C 18:1 fatty acids. A difference in PUFA of 0.40 (about 10%) was found between LFWDGS (4.86) and TWDGS (4.46), and this difference, while not significant, would support the increased amount of discoloration and lipid oxidation, especially toward the end of the retail display period. Fat percentage and moisture content were not affected by the dietary treatments ($P = 0.9707$ and $P = 0.9839$, respectively).

Although the LFWDG diet contained less fat on a percentage basis than the TWDGS diet (4.72% vs 6.91%), all of that fat was found in the grains portion of the wet DG. Much of the fat in the TWDGS diet came from the distillers solubles. We hypothesize that fats in the distillers soluble are hydrogenated in the rumen, while those contained within the grains fraction are more protected from biohydrogenation. This would explain why beef from cattle fed the LFWDG diet tended to have more PUFA, and



Corn, TWDGS (traditional levels of fat wet distillers grains with solubles), LFWDG (low-fat wet distillers grains).
[a,b,c]Means having different superscripts are different within days of display $P \leq 0.05$.

Figure 3. Lipid oxidation values for strip loin (m. *longissimus lumborum*) steaks from steers traditional levels of WDGS, low-fat WDG and corn-based diets.

Table 1. Sensory attributes of strip loin steaks from steers fed high and low fat WDG(S).

	Dietary treatments [1]			
Attributes[2]	Corn	TWDGS	LFWDG	*P*-value
Juiciness	5.24	5.18	5.08	0.15
Beef Flavor Intensity	5.61	5.63	5.65	0.88
Overall Tenderness	5.71[b]	5.89[a]	5.67[b]	< 0.01
Connective Tissue	6.20	6.21	6.16	0.74
Off-flavor	5.46[b]	5.59[a]	5.42[b]	0.02
WBSF (kg)	2.79	2.81	2.93	0.59

[1]Corn, TWDGS (traditional fat WDGS), LFWDG (low-fat WDG).
[2]Juiciness (1 extremely dry – 8 extremely juicy); beef flavor intensity (1 extremely bland – 8 extremely intense); overall tenderness (1 extremely tough – 8 extremely tender); connective tissue (1 abundant amount – 8 none detected); Off-flavor (1 strong/extreme off-flavor – 8 none detected).
[a, b]Means in the same row having different superscripts are different at $P \leq 0.05$.

Table 2. Least square means of mineral composition of strip loins (m. *longissimus lumborum*) from cattle fed different dietary regimes.

	Diet Composition[1]			
	Corn	TWDGS	LFWDG	*P*-value
Ca[2]	0.027[b]	0.039[a]	0.031[a,b]	0.023
P[2]	0.184	0.188	0.187	0.423
K[2]	0.391	0.396	0.398	0.873
Mg[2]	0.031	0.035	0.033	0.194
Zn[3]	35	35	34	0.899
Fe[3]	41[a,b]	50[a]	36[b]	0.072
Mn[3]	1.47[a]	1.00[a,b]	0.47[b]	0.076
Cu[3]	2.44[a]	1.80[a,b]	1.54[b]	0.046
S[2]	0.187	0.189	0.191	0.651
Na[2]	0.050[b]	0.055[a]	0.051[b]	0.041

[1] Corn, TWDGS (traditional levels of fat wet distillers grains with solubles), LFWDG (low-fat wet distillers grains).
[2] % on dry matter basis.
[3] ppm on dry matter basis.
[a, b] Means in same rows having different superscripts are different at $P \leq 0.05$.

Table 3. Weight percentage of fatty acids[1] and fat content of strip loin steaks (m. *longissimus lumborum*) from steers fed high and low fat WDG(S).

	Dietary Treatments[2]			
Fatty Acid	Corn	LFWDG	TWDGS	*P*-value
10:0	0.03	0.03	0.05	0.41
12:0	0.05	0.04	0.04	0.83
14:0	2.82	2.62	2.59	0.27
14:1 (n-5)	0.65	0.63	0.61	0.68
15:0	0.53[a]	0.46[b]	0.41[b]	0.01
iso 16:0	0.16	0.16	0.15	0.86
16:0	24.67[a]	23.50[b]	23.01[b]	0.01
16:1 (n-7)	3.12[a]	2.84[ab]	2.72[b]	0.03
17:0	1.65[a]	1.37[b]	1.43[b]	0.0001
iso 18:0	0.08	0.10	0.11	0.20
17:1 (n-7)	1.50[a]	1.22[b]	1.22[b]	<0.0001
18:0	13.02	13.12	13.98	0.12
18:1 *trans*	2.46[b]	3.68[a]	3.49[a]	0.01
18:1 (n-9)	42.55	41.55	42.19	0.58
18:1 (n-7)	1.11	0.85	0.92	0.24
18:1 δ13	0.15	0.18	0.16	0.81
18:1 δ14	0.14[b]	0.19[a]	0.18[a]	0.03
18:2 *trans*	0.04[b]	0.07[a]	0.08[a]	0.0003
19:0	0.06	0.08	0.07	0.75
18:2 (n-6)	2.16[c]	3.81[a]	3.43[b]	<0.0001
20:0	0.43[b]	0.52[a]	0.48[ab]	0.05
18:3 (n-3)	0.07[b]	0.11[a]	0.10[a]	0.02
20:1 (n-9)	0.07	0.04	0.06	0.21
18:2 *cis* 9 *trans* 11	0.03 [b]	0.07 [a]	0.06 [ab]	0.02
18:2 *cis* 10 *trans* 12	0.01	0.01	0.01	0.29
20:3 (n-6)	0.12[b]	0.17[a]	0.17[a]	0.0013
20:4 (n-6)	0.39	0.45	0.44	0.44
20:5 (n-3)	0.03	0.03	0.03	0.66
22:4 (n-6)	0.05	0.05	0.06	0.06
22:5 (n-3)	0.09	0.10	0.09	0.70
PUFA	2.99[b]	4.86[a]	4.46[a]	<0.0001
MUFA	51.76	51.17	51.54	0.79
Total Trans	2.50[b]	3.75[a]	3.57[a]	0.01
SFA	43.51	42.00	42.33	0.19
Others	1.74[b]	1.97[a]	1.67[b]	0.01
Omega 3	0.19[b]	0.23[a]	0.22[ab]	0.10
Omega 6	2.72[b]	4.48[a]	4.09[a]	<0.0001
Omega 6: Omega 3	16.99	20.15	19.29	0.50

[1]Weight percentage values are relative proportions of all peaks observed by Gas Chromatography.
[2]Corn, TWDGS (traditional levels of fat in wet distillers grains with solubles), LFWDG (low-fat wet distillers grains).
[a, b, c]Means in the same row having different superscripts are significant at $P \leq 0.05$.

it may explain decreased shelf life and increased oxidative rancidity of the samples from the LFWDG diets. In summary, LFWDG decreased shelf life and increased oxidative rancidity in retail displayed strip loin steaks.

[1]Asia L. Haack, graduate student; Amilton S. de Mello Jr., Ph.D.; Siroj Pokharel, graduate student; Lasika Senaratne, graduate student; Jerilyn Hergenreder, graduate student; Kim Varnold, graduate student; Chris R. Calkins, professor; Galen E. Erickson, professor, University of Nebraska–Lincoln Department of Animal Science; Timothy P. Carr, professor, Nutrition and Health Services, Lincoln, Neb; D. Dwain Johnson, professor, Meat Science, University of Florida, Gainesville, Fla.
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