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Effect of Feeding De-oiled Wet Distillers Grains Plus Solubles on Beef Fatty Acid Profiles

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Summary

A total of 336 steers were fed one of seven finishing diets: a corn-based control, 35%, 50%, or 65% inclusion of wet distillers grains plus solubles (WDGS), either traditional (full-fat) or de-oiled. At harvest, 15 low USDA Choice carcasses within each dietary treatment (n = 105) were selected to evaluate the effect of diet on the fatty acid profile of strip loin steaks aged seven days. Feeding WDGS increased the amount of polyunsaturated fatty acids (PUFA) in comparison to a corn based diet. Feeding de-oiled WDGS resulted in less PUFA's than the full-fat WDGS diets. It seems that the removal of the soluble fat portion of WDGS is effective at reducing the PUFA content and thus has the potential to reduce lipid oxidation in beef.

Introduction

Feeding cattle wet distillers grain plus solubles (WDGS) is a common practice in Nebraska as it is a corn by-product that lowers cost of production yet has a high nutritional value. The use of WDGS does present a challenge as it increases the polyunsaturated fatty acids (PUFA) content in beef, which results in higher lipid oxidation (2008 *Nebraska Beef Cattle Report*, pp. 120-121). More recently, ethanol plants have been extracting soluble fats found in WDGS by centrifugation for other uses (2011 *Nebraska Beef Cattle Report*, pp. 96-99). It is unclear if the decreased fat content in the WDGS will potentially reduce the amount of PUFA's in the fatty acid profile of beef and subsequently reduce lipid oxidation. Thus, this research was conducted to evaluate the effect of feeding de-oiled WDGS at three levels of inclusion compared to full-fat WDGS diets and a corn control diet on the fatty acid profile of beef.

Procedure

A total of 336 steers were fed one of seven dietary treatments: a corn-based control, 35%, 50%, or 65% inclusion of either traditional (full-fat) or de-oiled WDGS. The steers were subjected to these finishing diets for 147 days and after harvest, 15 low USDA Choice carcasses were selected within each treatment (n = 105) and strip loins were obtained. Vacuum sealed loins were aged for seven days (33°F) and ½-inch steaks we fabricated and immediately vacuum packed and stored in an ultralow-freezer (-112°F) for fatty acid determination and proximate analysis.

Fatty Acid Profile

Frozen samples were diced into small pieces, with no subcutaneous fat, and flash frozen in liquid nitrogen. The nitrogen frozen pieces were powdered in a metal cup blender and 1 g of powdered sample was weighed out to conduct fatty acid determination by gas chromatography. The chromatography was done using a Chromopack CP-Sil (0.25 mm x 100 m) column with an injector temperature of 518°F and a detector temperature of 572°F. The head pressure was set at 40 psi with a flow rate of 1.0 mL/min and a temperature programing system was used. The fatty acids were identified by their retention times in relation to known standards and the percent of fatty acid was determined by the peak areas in the chromatograph.

Proximate Analysis

Fat was extracted with ether following the Soxhlet extraction procedure. Moisture and ash were determined by using the LECO thermogravimetric analyzer. Fat, moisture, and ash percentages were added and subtracted from 100% to determine the amount of protein by difference.

Statistical Analysis

The experimental design was a 2x3+1 factorial that was analyzed with the GLIMMIX procedure in SAS (SAS Institute, Inc., Cary, N.C.). Dietary treatments were separated by the LS MEANS statement with the LINES option and TUKEY adjustment with an alpha level of 0.05. Additional comparisons were made between type of feed with estimates and contrasts statements.

Results

The proximate analysis data reflected that there were no differences in moisture ($P = 0.44$), fat ($P = 0.36$), protein ($P = 0.11$), or ash ($P = 0.89$) content in the beef from the seven dietary treatment. The overall averages for the nutritional constituents were: 71.70% moisture, 6.48% fat, 20.26% protein, and 1.56% ash.

Table 1 provides the fatty acid profiles of all the dietary treatments. Significant differences were found in the C16:1 fatty acid ($P < 0.0001$). The C16:1 fatty acid was prevalent in the corn control along with the 35% de-oiled WDGS diets. This fatty acid

Table 1. Amount[1] of fatty acids from steers feed different inclusion levels of de-oiled or full-fat WDGS (*L. dorsi*)

	Treatment								
	De-oiled WDGS			Full-Fat WDGS			Corn		
Fatty Acid	35%	50%	65%	35%	50%	65%	Control	SEM	*P*-value
C14:0	156.49	139.36	150.35	171.89	155.00	162.89	180.61	12.98	0.3583
C14:1	33.03	29.98	28.01	33.35	27.36	30.37	40.66	3.37	0.1017
C15:0	32.17	26.78	29.08	32.30	31.71	30.59	31.90	2.57	0.7120
C15:1	35.15	28.32	30.45	30.27	29.01	30.73	33.55	2.26	0.3346
C16:0	1588.06	1364.32	1501.57	1706.01	1543.98	1609.64	1679.52	102.47	0.2779
C16:1	149.67[ab]	132.58[b]	115.32[b]	145.11[b]	120.71[b]	128.23[b]	194.26[a]	10.68	< 0.0001
C17:0	103.35	86.42	93.81	103.89	104.32	98.18	98.83	7.78	0.6498
C17:1	73.43	64.38	59.95	66.60	65.26	61.78	80.07	5.51	0.1441
C18:0	1017.22	874.61	1029.27	1126.37	1109.31	1119.00	927.89	71.84	0.0917
C18:1T[2]	156.98[ab]	170.91[ab]	227.49[ab]	248.40[a]	248.03[a]	256.20[a]	120.12[b]	26.89	0.0011
C18:1	2514.37	2180.72	2243.01	2697.93	2383.59	2514.37	2590.88	164.98	0.2807
C18:1V[3]	252.13	245.10	256.12	268.89	255.38	288.60	318.34	19.13	0.1003
C18:2	227.16[b]	231.08[ab]	287.89[a]	294.87[a]	279.78[a]	301.36[a]	177.70[b]	19.49	< 0.0001
C18:3	0.00	5.59	8.63	10.06	12.03	8.94	0.00	2.28	0.5162
C20:1	31.94	26.69	28.58	38.48	30.85	33.51	30.89	3.24	0.2089
C20:4	47.62	42.39	45.41	45.33	42.77	45.83	46.29	2.13	0.5880
C22:0	18.31	14.51	14.83	16.10	14.39	16.09	12.04	1.48	0.2383
Total	6414.15	5637.85	6134.96	7005.20	6427.48	6692.61	6545.69	406.10	0.3469
SFA	2901.25	2494.55	2811.00	3151.19	2947.00	3024.60	2947.00	189.54	0.3260
UFA	3512.90	3143.30	3323.96	3854.01	3480.48	3668.00	3624.53	220.86	0.3595
SFA:UFA	0.82	0.79	0.85	0.82	0.85	0.83	0.81	0.02	0.1640
MUFA	3238.13	2869.46	2988.93	3512.47	3156.32	3320.22	3400.54	206.62	0.3107
PUFA	273.77[ab]	273.84[ab]	335.03[a]	341.54[a]	324.15[a]	347.79[a]	223.98[b]	20.75	0.0002

[1]Amount (mg/100g tissue) of fatty acid in powdered loin sample determined by gas chromatography.
[2]C18:1T is the trans elaidic acid.
[3]C18:1V is the cis vaccinic acid.
[a,b]Means in the same row with different superscripts are significantly different ($P < 0.05$).

was found in significantly less amount in the 50% and 65% de-oiled and all full-fat WDGS diets.

Differences were observed in two of the 18 carbon fatty acids: C18:1T and C18:2. The C18:1T fatty acid showed a higher concentration in the de-oiled and full-fat WDGS ($P = 0.0011$). This indicates that WDGS, regardless of the fat content in the feed, will increase the C18:1T fatty acid concentrations in relation to a corn control diet. The C18:2 fatty acid was found in higher amount in the three full-fat WDGS and was not statistically different than the amount found in the 50% and 65% de-oiled WDGS. The 35% de-oiled WDGS and the corn control had significantly less C18:2 ($P < 0.0001$).

No differences were seen in the amounts of monounsaturated fatty acids (MUFA), saturated fatty acids (SFA), unsaturated fatty acids (UFA), the SFA:UFA relation, or the total amount of fatty acids.

Significant difference was seen with the PUFA content ($P = 0.0002$). The corn control had the least amount of PUFA's (223.98 mg/100g). The 35% and 50% de-oiled WDGS diets (273.77 and 273.84 mg/100g, respectively) had intermediate PUFA values that were not statistically different than the corn control or the remaining diets. This indicates that 65% de-oiled WDGS and the three full-fat WDGS had the most elevated PUFA contents but were not statistically different than the 35% and 50% de-oiled dietary treatments. Therefore, the lowest PUFA content was obtained with the corn control diet and the lower inclusion levels of the de-oiled feeds, confirming the increase in PUFA's typically associated with the feeding of WDGS.

Table 2 summarizes the fatty acid profiles of the de-oiled WDGS, full-fat WDGS, and corn control diets averaged across dietary inclusion of WDGS. The corn control had significantly higher concentrations of C14:1 and C16:1 fatty acids in relation to the de-oiled and full-fat WDGS. The C17:1 fatty acid was found in higher amounts in the corn control and in least amount in the full-fat WDGS, while the de-oiled WDGS had an intermediate amount that was not statistically different from the corn control or the full-fat WDGS. The de-oiled WDGS had the least amount of C18:0. The full-fat WDGS had the most C18:1T and had an intermediate amount of C18:1V where the corn control was the highest and the de-oiled WDGS were the lowest. The C18:2 fatty acid was most abundant in the full-fat WDGS, followed by the de-oiled WDGS and lastly the corn control. This same trend was seen in the PUFA content, where, the highest amount was obtained with the full-fat WDGS (337.83 mg/100g), followed by

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the de-oiled WDGS (294.55 mg/100g), and lastly the corn control (223.98 mg/100g) was the lowest; and they were all significantly different from each other (P <0.0001).

These findings confirm that feeding WDGS increases the amount of PUFA's in comparison to a corn based diet. Feeding de-oiled WDGS resulted in less PUFA's than all full-fat diets. It seems that the removal of the soluble fat portion of WDGS is effective at reducing the PUFA content and thus has the potential to reduce lipid oxidation in beef.

Table 2. Amount[1] of fatty acids from steers feed de-oiled or full-fat WDGS and a corn control (*L. dorsi*).

	Dietary Treatment			
Fatty Acid	De-oiled	Full-fat	Corn Control	*P*-value
C14:0	148.73	163.26	180.61	0.0842
C14:1	30.29[b]	30.43[b]	40.66[a]	0.0179
C15:0	29.34	31.53	31.90	0.5012
C15:1	31.38	30.00	33.55	0.3861
C16:0	1484.65	1619.88	1679.52	0.1443
C16:1	132.53[b]	131.35[b]	194.26[a]	< 0.0001
C17:0	94.53	102.13	98.83	0.4858
C17:1	65.92[ab]	64.55[b]	80.07[a]	0.0460
C18:0	973.70[b]	1118.23[a]	927.89[a]	0.0170
C18:1T	185.13[b]	250.93[a]	120.12[b]	< 0.0001
C18:1	2312.70	2524.11	2590.88	0.1884
C18:1V	251.12[b]	270.96[ab]	318.34[a]	0.0106
C18:2	248.71[b]	292.00[a]	177.70[c]	< 0.0001
C18:3	7.87	10.62	0.00	0.1563
C20:1	29.03	34.36	30.89	0.1249
C20:4	45.14	44.64	46.29	0.7992
C22:0	15.76	15.65	12.04	0.2099
Total	6062.32	6708.43	6545.69	0.1424
SFA	2735.60	3040.93	2921.16	0.1439
UFA	3326.72	3667.50	3624.53	0.1475
SFA:UFA	0.82	0.83	0.81	0.3533
MUFA	3032.18	3329.67	3400.54	0.1332
PUFA	294.55[b]	337.83[a]	223.98[c]	< 0.0001

[1]Amount (mg/100g tissue) of fatty acid in powdered loin sample determined by gas chromatography
[a,b,c]Means in the same row with different superscripts are significantly different ($P < 0.05$)

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