Increased Beef Oxidation from Feeding Wet Distillers Grains with Solubles is not Caused by the Solubles Fraction

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Abstract- **Feeding distillers grains with solubles (versus corn) to cattle causes the meat to oxidize more rapidly due to an increase in polyunsaturated fatty acids. The objective of this research was to determine if the change in fatty acid profile is caused by the solubles fraction (condensed distillers solubles; CDS). Cattle (n=250) were fed a corn-based diet (without distillers grains) containing 0, 9, 18, 27, or 36% CDS (DM basis) for 132 days. After harvest, 15 strip loins, grading USDA Choice, were selected from each treatment and aged for 14 days. Three steaks from each strip loin were placed in retail display for 0, 4, and 7 days. Oxidation was measured by quantifying thiobarbituric acid reactive substances. Fatty acid analyses were conducted on d 0 steaks. Polyunsaturated fatty acid levels were unaffected by treatment ($P = 0.68$). The control diet (0% CDS) had significantly higher amounts of unsaturated fatty acids and monounsaturated fatty acids than all other treatments ($P = 0.04$ and $P = 0.03$, respectively). Levels of C16:1, C17:1, C18:1, and vaccenic acid all decreased as CDS inclusion increased ($P = 0.03$, $P = 0.03$, $P = 0.004$, and $P < 0.0001$, respectively). Despite the small, but significant changes in fatty acid profile, there were no differences among treatments for oxidation ($P = 0.19$). These data suggest that the soluble fraction is not responsible for the negative oxidation and shelf life effects that often occur when cattle are fed distillers grains with solubles.**

Keywords- **Condensed distillers solubles, Beef, Fatty acid profile**

I. INTRODUCTION

Feeding wet distillers grains with solubles (WDGS) to cattle causes an increase in polyunsaturated fatty acids (PUFA) and increased oxidation rates in the meat [1,2]. With increased oxidation rates comes decreased shelf-life and a major loss of steak value. When distillers grains, without solubles, are fed to cattle the same effects can be seen [3]. Little research has been conducted to describe the effects of the solubles portion on beef shelf life. The objective of this project was to determine if feeding only solubles to cattle would have the same effects on shelf life as when distillers grains are fed.

II. MATERIALS AND METHODS

A. Diets and sample collection

Condensed distillers solubles (CDS) were fed to cattle (n = 250) with inclusion rates of 0, 9, 18, 27, and 36% (DM basis). No distillers grains were added to any diets. After 132 days cattle were harvested at the Greater Omaha Packing plant in Omaha, Nebraska. Seventy-five carcasses grading USDA Choice, 15 from each treatment, were selected. Strip loins were wet aged for 14 days and then fabricated.

B. Retail display

Three steaks were cut from each strip loin. Each steak was cut ½-inch thick and assigned to 0, 4, or 7 days of retail display, respectively. The retail display case was checked every day to ensure the temperature remained around 2°C. Steaks were repositioned everyday to ensure all samples received the same amount of exposure to light. After retail display steaks were vacuum packaged and frozen at -20°C until further testing.

C. Lipid oxidation

For oxidation analysis, partially frozen 0, 4, and 7 day steaks were cut into small cubes, flash frozen using liquid nitrogen, powdered using a Waring blender, and stored at -80°C. A thiobarbituric acid reactive substances assay was used, as described by Buege and Aust [4] and modified by Ahn et al. [5], on the powdered samples to measure oxidation.

D. Fatty acid profiles

Powdered samples from 0 day steaks were used to analyze fatty acid profiles. Gas chromatography was used to determine fatty acid content as described by Folch et al. [6] using a Chrompack CP-Sil 88 (0.25 mm x 100 m) column.

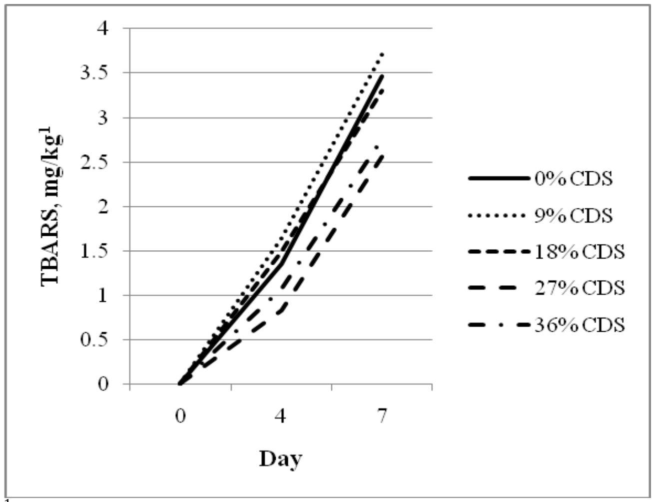
E. Statistical analysis

Data were analyzed by ANOVA in the Mixed procedure of SAS (Version 9.1) [7] using a randomized complete block design. For lipid oxidation data, the model included treatment and day as the fixed effects with pen and pen by day interaction as random effects and was analyzed using repeated measures. The fatty acid profile model included treatment as a fixed effect and pen as a random effect. Least square means with the probability of difference (pdiff) option was used for mean separation; with significance determined at $P \leq 0.05$ levels.

III. RESULTS

A. Lipid oxidation

Neither dietary treatments nor treatment by day interaction had a significant effect ($P > 0.10$) on amount of oxidation (Figure 1). Other studies [8] found no difference in oxidation, both pre- and post display, between beef from cattle fed corn or 15% WDGS.



[1]TBARS = Thiobarbituric acid reactive substances

Figure 1. Effect of condensed distillers solubles inclusion on oxidation values during retail display ($P > 0.10$).

B. Fatty acid profiles

Fatty acid content was the only parameter affected by dietary treatment (Table 1). The control diet created beef that had significantly higher levels of total unsaturated fatty acids than all other treatments ($P = 0.04$). Total PUFA content was unaffected by treatment ($P = 0.68$), but meat from animals fed the control diets had significantly higher amounts of monounsaturated fatty acids (MUFA) ($P = 0.03$). Conversely, others [8,9] found that inclusion of WDGS increased PUFA levels while MUFA were unaffected. This infers that it is the distillers grains portion that causes the shift towards increased PUFA levels.

Levels of C16:1, C17:1, C18:1, and C18:1 (*n*-7) (cis-vaccenic acid) significantly decreased as CDS inclusion increased ($P = 0.03$, $P = 0.03$, $P = 0.004$, and $P < 0.0001$, respectively). Conversely, except for C18:1 (*n*-7), another researcher [8] found that none of those MUFA were affected by the inclusion of WDGS in the diet. It would appear that solubles have an effect on the MUFA levels in beef. An isomer of conjugated linoleic acid, C18:2 Δ9t,12t, was found to linearly increase as inclusion of CDS increased ($P < 0.0001$).

Table 1. Effect of corn distillers solubles inclusion on weight percentage values of fatty acids

	CDS[1], %						
Fatty Acids	0	9	18	27	36	SEM	*P*-value
C10:0	0.04	0.04	0.04	0.04	0.04	0.002	0.60
C12:0	0.06	0.06	0.06	0.06	0.06	0.003	0.43
C14:0	2.85	2.90	2.84	3.06	2.91	0.098	0.49
C14:1	0.71	0.63	0.59	0.67	0.59	0.039	0.13
C15:0	0.52	0.52	0.51	0.54	0.51	0.020	0.81
*iso*16:0	0.20	0.24	0.18	0.21	0.18	0.021	0.23
C16:0	25.38	25.41	25.40	25.04	24.52	0.279	0.15
C16:1	3.54^{a}	3.44^{ab}	3.17^{bc}	3.27^{abc}	3.04^{c}	0.107	0.03
C17:0	1.97	1.59	1.59	1.57	1.48	0.068	0.46
*iso*18:0	0.12	0.14	0.10	0.13	0.11	0.015	0.37
C17:1	1.24^{a}	1.13^{ab}	1.06^{bc}	1.07^{bc}	0.95^{c}	0.059	0.03
C18:0	12.44^{b}	13.51^{a}	13.76^{a}	13.70^{a}	14.11^{a}	0.334	0.02
C18:1 *trans*	2.85^{c}	2.56^{c}	3.51^{bc}	4.68^{ab}	5.77^{a}	0.442	<0.01
C18:1 (*n*-9)	39.13^{a}	37.74^{ab}	37.58^{ab}	36.53^{bc}	34.95^{c}	0.705	<0.01
C18:1 (*n*-7)	2.35^{a}	2.27^{a}	2.00^{b}	1.85^{bc}	1.73^{c}	0.069	<0.01
C18:1 Δ13t	0.39^{a}	0.15^{b}	0.15^{b}	0.28^{ab}	0.21^{b}	0.051	0.01
C18:1 Δ14t	0.25	0.24	0.26	0.27	0.26	0.011	0.33
C19:0	0.09^{cd}	0.10^{cd}	0.11^{c}	0.12^{b}	0.13^{a}	0.004	<0.01
C18:2 Δ9t,12t	0.09^{c}	0.10^{b}	0.11^{b}	0.13^{a}	0.14^{a}	0.005	<0.01
C18:2 Δ9c,12c	3.12	3.20	3.10	3.37	3.46	0.131	0.23
C20:0	0.08	0.07	0.07	0.07	0.07	0.006	0.58
C18:3 Δ6c,9c,12c	0.16	0.14	0.15	0.15	0.14	0.008	0.28
C18:3 (*n*-3)	0.16	0.16	0.17	0.16	0.17	0.005	0.16
C20:1	0.22^{bc}	0.19^{c}	0.23^{b}	0.25^{b}	0.30^{a}	0.013	<0.01
C20:3	0.18^{ab}	0.19^{a}	0.16^{bc}	0.16^{bc}	0.15^{c}	0.010	0.02
C20:4	0.57	0.66	0.54	0.56	0.50	0.046	0.17
C22:4	0.09	0.10	0.09	0.09	0.08	0.007	0.12
C22:5	0.17	0.13	0.11	0.12	0.10	0.026	0.46
Total FA	97.60^{a}	97.19^{b}	96.96^{bc}	96.91^{bc}	96.69^{c}	0.122	<0.01
SFA	43.46	44.58	44.67	44.55	44.14	0.459	0.34
UFA	54.14^{a}	52.61^{b}	52.29^{b}	52.36^{b}	52.55^{b}	0.454	0.04
SFA:UFA	0.81	0.85	0.86	0.85	0.84	0.016	0.20
MUFA	49.60^{a}	47.91^{b}	47.84^{b}	47.62^{b}	47.81^{b}	0.461	0.03
PUFA	4.55	4.69	4.44	4.74	4.75	0.178	0.68

[1]CDS = corn distillers solubles

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$)

IV. CONCLUSION

Unlike distillers grains, CDS do not affect polyunsaturated fatty acids and therefore the meat is not as affected by oxidation. Feeding CDS to cattle has no detrimental effects on beef shelf life and may be safely fed to cattle at inclusion levels as high as 36%.

REFERENCES

1. Senaratne, L.S., Calkins, C.R., de Mello Jr., A.S., Carr, T.P., and Erickson, G.E. (2009). Fatty acid composition of beef from cattle fed wet distillers grains diets supplemented with vitamin E. Nebraska Beef Report, MP92, 110-112.
2. Senaratne, L.S., Calkins, C.R., de Mello Jr., A.S., and Erickson, G.E. (2009). Vitamin E mitigates the boost in lipid oxidation of beef due to wet distillers grains feeding. Nebraska Beef Report, MP92, 113-115.
3. Haack, A.L., de Mello Jr., A.S., Pokharel, S., Senaratne, L., Hergenreder, J., Varnold, K., Calkins, C.R., Erickson, G.E., Carr, T.P., and Johnson, D.D. (2011). Low-fat distillers grains and beef quality. Nebraska Beef Report, MP94, 96-99.
4. Buege, J., and Aust, S.D. (1978). Microsomal lipid peroxidation. Method Enzymol., 5, 302-310.
5. Ahn, D.U., Olsen, D.G., Jo, C., Chen, X., Wu, C., and Lee, J.I. (1998). Effect of muscle type, packaging, and irradiation on lipid oxidation, volatile production, and color in raw pork patties. Meat Sci., 49, 27-39.
6. Folch, J., Lees, M., and Stanley, G.H.S. (1957). A sample method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem., 226, 497-509.
7. SAS. (2004). Statistical Analysis Software User's Guide: Statisitics (Version 9.1). North Carolina: SAS Institute Inc.
8. Gill, R.K., VanOverbeke, D.L., Depenbusch, B., Drouillard, J.S., and DiCostanzo, A. (2008). Impact of beef cattle diets containing corn or sorghum distillers grains on beef color, fatty acid profiles, and sensory attributes. J. Anim. Sci., 86, 923-935.
9. Kinman, L.A., Hilton, G.G., Richards, C.J., Morgan, J.B., Krehbiel, C.R., Hicks, R.B., Dillwith, J.W., and VanOverbeke, D.L. (2011). Impact of feeding various amounts of wet and dry distillers grains to yearling steers on palatability, fatty acid profile, and retail case life of longissimus muscle. J. Anim. Sci., 89, 179-184.