Effects of Feeding High Levels of Wet Distillers Grains and Straw on Beef Quality

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Summary

Cattle (n = 336; 595 ± 20 lb) were fed one of seven diets (corn/5% straw; 40% distillers grain (DG)/5% straw; 70% DG/8% straw; 70% DG/25% straw; 77.5% DG/9% straw; 77.5% DG/17% straw, and 85% DG/10% straw – DM basis) to measure effects of feeding high levels of DG on shelf life of aged beef. Except for 70% DG/25% straw, strip loins were cut into three steaks each after 20 days of postmortem aging for 0, 4, and 7 days of retail display. The treatment having 70% DG/8% straw had the greatest oxidation status. Trans fatty acids and polyunsaturated fatty acids increased significantly in the strips of cattle fed high levels of WDGS and straw. Treatments with the highest levels of DG (85% DG/10% straw) or straw (77.5% DG/17% straw) had the most discoloration and were darkest at day three and four of retail display.

Introduction

Wet distillers grains plus soluble (WDGS) can be used as a replacement for corn and provide supplemental protein. Feeding WDGS decreases the feed to gain ratio (F:G) in cattle and is very economical to use in Nebraska (*2010 Nebraska Beef Cattle Report,* pp. 42-43 and 61-62). Previous research has shown an increase in discoloration of steaks when cattle are fed with high levels of distillers grain (*2010 Nebraska Beef Cattle Report,* pp. 99-101). Beef from cattle fed high levels of WDGS contains large amounts of polyunsaturated fatty acids (PUFA) which are responsible for increased rancidity in meat and decreased color stability (*2009 Nebraska Beef Cattle Report,* pp. 107-109). This research was conducted to determine if meat quality continues to change when very high levels of WDGS (> 50%) are fed with straw to maintain rumen pH and manage any sulfur related challenges.

Procedure

Cattle (n = 336; 595 ± 20 lb) were assigned randomly to one of the 36 pens. Pens were assigned randomly to one of seven dietary treatments (corn/5% straw; 40% DG/5% straw, 70% DG/8% straw, 70% DG/25% straw, 77.5% DG/9% straw, 77.5% DG/17% straw, and 85% DG/10% straw – DM basis) as described by Rich et al. (*2011 Nebraska Beef Cattle Report,* pp. 84-86). Steers on corn/5% straw, 40/5, 70/8, and 77.5/9 diets were fed up to 183 days and the remaining 70/25, 77.5/17 and 85/10 diets were fed 225 days so as to attain similar final BW. Strip loins (m. *Longissimus lumborum*), 9-15 per treatment (all USDA Choice), (IMPS # 180 PSO2; NAMP, 2007) were collected from Greater Omaha Packing Co. (except that no loins were obtained for the 70/25 treatment) and cut into three steaks (1 inch thick) after 20 days of postmortem aging. The first steak of each muscle was vacuum packaged using nylon-polyethylene vacuum pouches (3 mil STD barrier, Prime Sources, St. Louis, Mo.) on a Multivac Packaging machine (MULTIVAC C500, Multivac Inc., Kansas City, Mo.) and frozen for laboratory analyses of fat content, 0 day oxidative rancidity (TBARS), fatty acids and proximate analysis. The second and third steaks of each muscle were packaged on Styrofoam trays (Styro-Tech, Denver, Colo.), overwrapped with oxygen permeable polyvinyl chloride film and placed on a table in a cooler maintained at 32-36°F for a retail display. Steaks from four days were analyzed for oxidative rancidity (TBARS) and steaks from seven days were analyzed for color and TBARS analysis.

For this experiment, TBARS were run to measure the rancidity of the muscle as explained by Senaratne et al., *2009 Nebraska Beef Cattle Report,* pp. 113-115. Fatty acid composition in a steak was determined by following the same procedures as described by de Mello Jr. et al (*2008 Nebraska Beef Cattle Report,* pp. 108-109). Subjective color evaluation was done by three to four trained panelists from the Department of Animal Science at the University of Nebraska–Lincoln. Color evaluation was based on the discoloration percentage that ranges from 0 to 100%. The objective color was read with the Hunter Lab® Mini Scan XE Plus (Model 45/0-L, Hunter Laboratory Associates, Inc., Reston, Va.) a portable colorimeter equipped with a 1-inch aperture and using illuminant D65 at 10° standard observer. Color was read on the strip loin steaks (m. *longissimus lumborum*) that were kept for seven days in a retail display. In colorimeter readings, the average

Table 1. Amount of malondialdehyde mg/kg (oxidative rancidity) from strips (m. *longissimus lumborum*) of steers fed high level of WDGS with straw.

Treatment	Amount
Control 5 St[1]	0.30[b]
40 DG 5 St[2]	0.31[b]
70 DG 8 St[3]	2.43[a]
77.5 DG 9 St[4]	1.76[ab]
77.5 DG 17 St[5]	2.28[ab]
85 DG 10 St[6]	1.75[ab]

LS-means with the different letters [a,b] are significantly different at $P < 0.05$.
[1]Control 5 St: corn diet and 5% straw.
[2]40 DG 5 St: diet with 40% WDGS and 5% straw.
[3]70 DG 8 St: diet with 70% WDGS and 8% straw.
[4]77.5 DG 9 St: diet with 77.5% WDGS and 9% straw.
[5]77.5 DG 17 St: diet with 77.5% WDGS and 17% straw.
[6]85 DG 10 St: diet with 85% WDGS and 10% straw.

Table 2. **Amount of fat and moisture percentage from USDA Choice grade strips (m. *longissimus lumborum*) of steers fed high levels of WDGS with straw.**

Attribute	Treatments							Contrasts	
	Control 5 st[1]	40 DG 5 St[2]	70 DG 8 St[3]	77.5 DG 9 St[4]	77.5 DG 17 St[5]	85 DG 10 St[6]	*P*-Value	Control vs. WDGS	Non-straw vs. straw
Marbling	Mt 42^{abc}	Mt 64^{a}	Mt 52^{ab}	Mt 22^{bc}	Mt 61^{a}	Mt 21^{c}	0.02	0.85	0.12
Fat content (%)	9.25^{bc}	10.38^{ab}	9.25^{bc}	7.53^{d}	10.79^{a}	8.68^{dc}	0.0003	0.87	0.06
Moisture content (%)	71.95^{a}	71.62^{a}	71.53^{ab}	71.47^{ab}	70.72^{b}	69.87^{c}	< 0.0001	0.002	0.08

$^{a,b,c,\,d}$Means in the same row having different superscripts are significantly different at $P < 0.05$.
[1]Control 5 St: corn diet and 5% straw.
[2]40 DG 5 St: diet with 40% WDGS and 5% straw.
[3]70 DG 8 St: diet with 70% WDGS and 8% straw.
[4]77.5 DG 9 St: diet with 77.5% WDGS and 9% straw.
[5]77.5 DG 17 St: diet with 77.5% WDGS and 17% straw.
[6]85 DG 10 St: diet with 85% WDGS and 10% straw.
Mt in marbling refers to modest $^{500\text{-}599}$ in Choice grade.

Table 3. **Weight percentage[1] of fatty acids of strip (m. *longissimus lumborum*) steaks from steers fed high levels of wet distillers grains with straw.**

Fatty acids	Dietary Treatments (% WDGS – DM basis)						
	Control[1] 5 St	40 DG 5 St[2]	70 DG 8 St[3]	77.5 DG 9 St[4]	77.5 DG 17 St[5]	85 DG 10 St[6]	*P*- value
14:1-(n-5) - Myristoleic	0.75^{a}	0.55^{b}	0.43^{bc}	0.43^{bc}	0.46^{bc}	0.42^{c}	<0.01
15:0 - Pentadecanoic	0.55^{a}	0.53^{ab}	0.47^{bc}	0.47^{bc}	0.38^{d}	0.46^{c}	<0.01
ISO 16:0 - Isopalmitic	0.43^{a}	0.26^{c}	0.44^{a}	0.39^{ab}	0.31^{bc}	0.39^{ab}	<0.01
16:0 - Palmitic	26.23^{a}	24.44^{b}	23.56^{c}	22.68^{cd}	22.48^{d}	23.39^{cd}	<0.01
16:1- (n-7) - Palmitoleic	3.85^{a}	2.54^{b}	2.31^{bc}	2.08^{c}	2.47^{bc}	2.25^{bc}	<0.01
17:0 - Heptadecanoic	1.52^{a}	1.46^{a}	1.18^{b}	1.21^{b}	0.84^{c}	1.00^{c}	<0.01
ISO 18:0 - Isosetearic	0.29^{bc}	0.23^{c}	0.43^{a}	0.38^{ab}	0.36^{ab}	0.42^{a}	<0.01
17:1- (n-7) - heptadecenoic	1.30^{a}	0.86^{b}	0.68^{c}	0.68^{cd}	0.52^{d}	0.56^{cd}	<0.01
18:0 - stearic	12.70^{d}	14.94^{c}	16.42^{b}	16.35^{bc}	17.86^{ab}	18.74^{a}	<0.01
18:1T- Elaidic	2.14^{c}	4.74^{b}	6.73^{a}	7.51^{a}	5.60^{b}	5.49^{b}	<0.01
18:1- (n-9)- Oleic	38.38^{a}	35.90^{b}	31.74^{c}	32.21^{c}	34.75^{b}	32.25^{c}	<0.01
(18:1 n-7)- Vaccenic	1.49^{a}	1.06^{b}	1.39^{a}	1.47^{a}	0.81^{b}	0.94^{b}	<0.01
18:1 Δ 13	0.11^{d}	0.21^{b}	0.24^{ab}	0.27^{a}	0.17^{c}	0.22^{b}	<0.01
18:1 Δ 14	0.04^{b}	0.07^{ab}	0.07^{ab}	0.07^{ab}	0.08^{a}	0.08^{a}	0.11
18:2T- Linoelaidic	0.08^{c}	0.19^{b}	0.2^{ab}	0.23^{ab}	0.23^{a}	0.20^{ab}	<0.01
19:0- Nonadecanoic	0.07^{c}	0.24^{b}	0.26^{ab}	0.28^{ab}	0.30^{a}	0.28^{a}	<0.01
18:2- (n-6)- Linoleic	3.27^{d}	5.45^{c}	6.83^{a}	6.69^{a}	5.85^{a}	6.30^{ab}	<0.01
20:0- Eicosanoic	0.04^{b}	0.11^{a}	0.11^{a}	0.13^{a}	0.14^{a}	0.14^{a}	<0.01
18:3- (n-3)- Linolenic	0.12^{b}	0.21^{a}	0.21^{a}	0.25^{a}	0.22^{a}	0.25^{a}	<0.01
20:1- (n-9)- Eicosenoic	0.25^{c}	0.35^{bc}	0.29^{bc}	0.41^{ab}	0.52^{a}	0.31^{bc}	<0.01
CLA *c9, t11*	0^{b}	0.01^{a}	0^{b}	0^{b}	0^{b}	0^{b}	0.1
CLA *c12, t10*	0.01^{c}	0.05^{b}	0.06^{ab}	0.10^{a}	0.09^{ab}	0.10^{a}	<0.01
20:2- Eicosadienoic acid	0.07^{a}	0.08^{a}	0.05^{a}	0.03^{a}	0.04^{a}	0.10^{a}	0.33
20:3- (n-6)- Homogamma Linolenic	0.26^{ab}	0.21^{b}	0.30^{a}	0.30^{a}	0.23^{b}	0.26^{ab}	0.02
20:4- (n-6)- Arachidonic	0.83^{a}	0.57^{b}	0.91^{a}	0.82^{a}	0.60^{b}	0.80^{a}	<0.01
22:4- Adrenic acid	0.02^{a}	0.03^{a}	0.03^{a}	0.02^{a}	0.03^{a}	0.03^{a}	0.96
22:5- (n-3)- Docosapentaenoic	0.02^{a}	0^{a}	0.02^{a}	0.04^{a}	0.02^{a}	0.01^{a}	0.61
Trans	2.37^{d}	5.28^{c}	7.31^{ab}	8.20^{a}	6.18^{bc}	6.09^{c}	<0.01
PUFA	4.67^{d}	6.80^{c}	8.62^{a}	8.50^{a}	7.32^{bc}	8.06^{ab}	<0.01
OMEGA 3	0.15^{c}	0.21^{bc}	0.23^{ab}	0.29^{a}	0.25^{ab}	0.26^{ab}	<0.01
OMEGA 6	4.37^{d}	6.26^{c}	8.07^{a}	7.84^{a}	6.70^{bc}	7.40^{ab}	<0.01
OMEGA6:3	29.39^{a}	30.49^{a}	32.52^{a}	28.21^{a}	28.28^{a}	29.13^{a}	0.77

[1]Weight percentage values are relative proportions of all peaks observed by gas chromatography.
^{a,b,c,d}Means in the same row having different superscripts are significant at $P \leq 0.05$.
[1]Control 5 St: corn diet and 5% straw.
[2]40 DG 5 St: diet with 40% WDGS and 5% straw.
[3]70 DG 8 St: diet with 70% WDGS and 8% straw.
[4]77.5 DG 9 St: diet with 77.5% WDGS and 9% straw.
[5]77.5 DG 17 St: diet with 77.5% WDGS and 17% straw.
[6]85 DG 10 St: diet with 85% WDGS and 10% straw.

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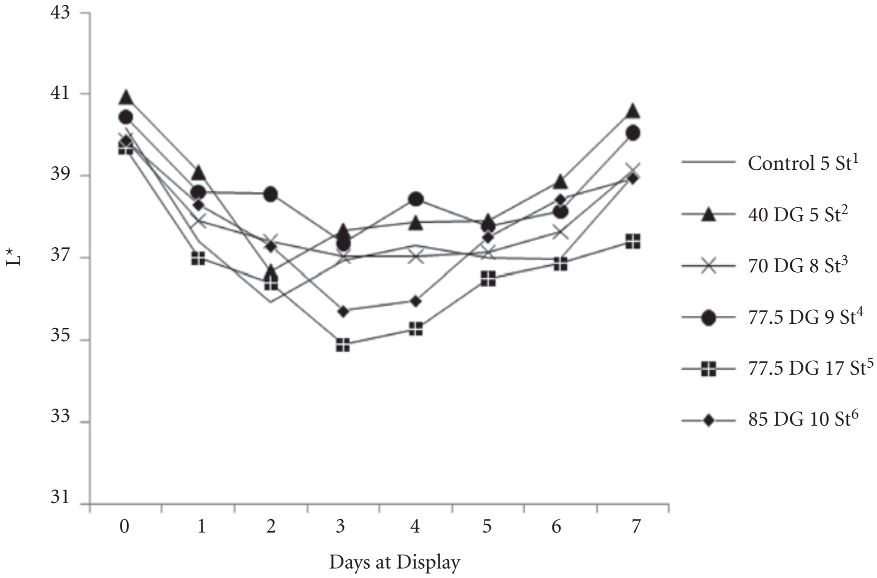
of L* (measure of darkness to lightness), a* (measure of redness), and b* (measure of yellowness) were taken. Data were analyzed using the GLIMMIX procedure of SAS (Version 9.2, SAS Institute Inc. 2009). Where significance ($P \leq 0.05$) was indicated by ANOVA, means separations were performed using the LSMEANS and DIFF functions of SAS.

Results

Oxymyoglobin becomes stable when there is high partial pressure and concentration of oxygen (O_2). High concentration of O_2 and O_2-permeable film ultimately leads to higher lipid oxidation. There was no significant treatment-by-day effect for oxidative rancidity in the strip steaks of steers; however, oxidative rancidity was significantly different among dietary treatments (Table 1). Steaks from cattle fed 70% DG/8% straw were more prone to oxidation than steaks from cattle fed corn or 40% DG/5% straw. Although the amount of straw added in the diet (77.5% DG/17% straw) was almost double in comparison to other diets, there were no statistical differences among treatments containing straw.

The steaks for the research were USDA Choice; their marbling data, fat content, and moisture content are shown in Table 2. The effects of these treatments on overall grade and marbling are shown elsewhere in this Beef Cattle Report (*2011 Nebraska Beef Cattle Report*, pp. 55-56). As shown in Table 3, strips from cattle fed high levels of WDGS and straw had significantly greater levels of polyunsaturated fatty acids (PUFA) and trans fatty acids in comparison to the corn-fed group whereas there was a significant decrease of 18:1 n-7 fatty acid in cattle fed high levels of WDGS and straw. Camfield et al. (1997, *Journal of Animal Science* 75:1837-1844) reported that PUFA are responsible for discoloration of meat whereas lower levels of 18:1 n-7 fatty acid are associated with off flavor production. de Mello Jr. et al. (*2008 Nebraska Beef Cattle Report,* pp. 110-111) reported



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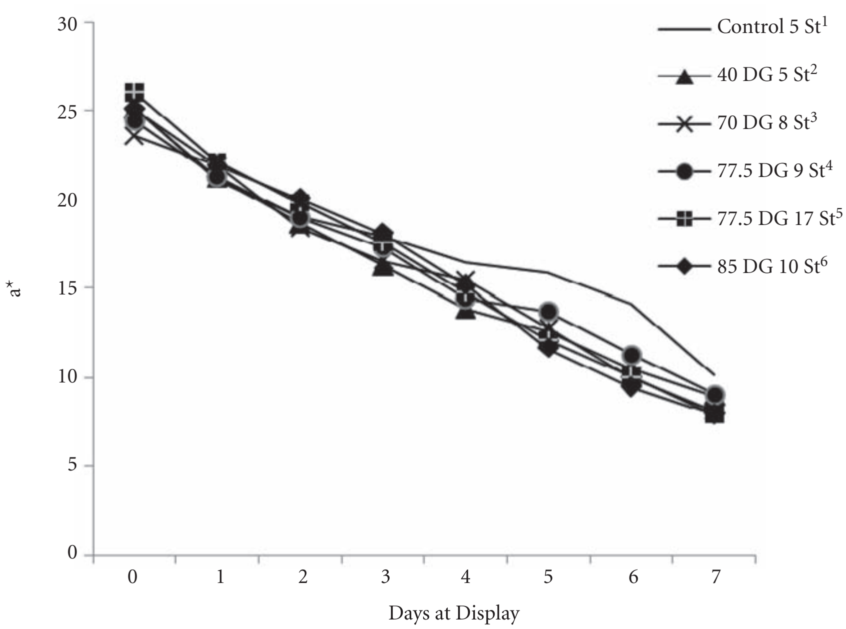
[6]85 DG 10 St: diet with 85% WDGS and 10% straw.

Figure 1. L* values of strips steaks (m. *longissimus lumborum*) from steers fed corn, high level WDGS, and straw.



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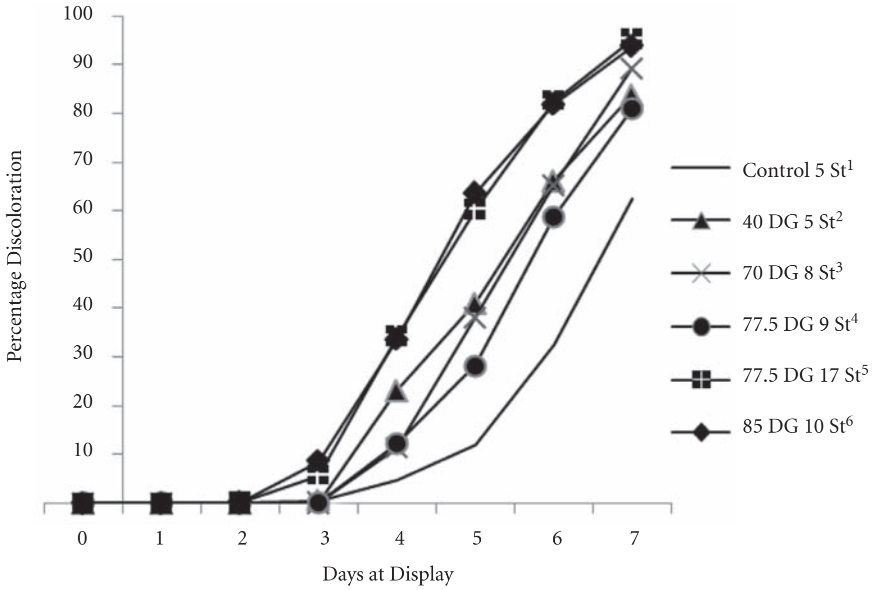
[5]77.5 DG 17 St: diet with 77.5% WDGS and 17% straw.
[6]85 DG 10 St: diet with 85% WDGS and 10% straw.

Figure 2. a* values of strips steaks (m. *longissimus lumborum*) from steers fed corn, high level WDGS, and straw.



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[6]85 DG 10 St: diet with 85% WDGS and 10% straw.

Figure 3. Visual discoloration of strips steaks (m. *longissimus lumborum*) from steers fed corn, high level WDGS, and straw.

increases in PUFA and trans fatty acid levels from feeding WDGS. Similar results were shown by de Mello Jr. et al. (2009 *Nebraska Beef Cattle Report*, pp. 107-109) and Senaratne et al., (2009 *Nebraska Beef Cattle Report*, pp. 110-112).

The L* (lightness) values decreased then increased from day 0 to 7 of retail display for all treatments (Figure 1). The treatments with the most DG (85% DG/10% straw) or straw (77.5 %DG/17% straw) were darkest at day 3 and day 4. The a* (redness) values decreased from day 0 to 7. Steaks from cattle fed corn were superior in redness from four to seven days of retail display in comparison with the steers fed high levels of WDGS (Figure 2). Discoloration percentage increased with retail display time. Meat from cattle fed 85% DG/10% straw and 77.5% DG/17% straw had the greatest discoloration whereas cattle fed corn had the lowest discoloration (Figure 3). It should be noted that animals receiving these treatments were fed 42 days longer than most of the other treatments in order to reach an appropriate slaughter endpoint. Senaratne et al. (*2009 Nebraska Beef Cattle Report,* pp. 116-117) demonstrated that 40% of distillers grains with solubles resulted in greater discoloration regardless of aging period.

In summary, meat from cattle fed high levels of WDGS had significantly greater values of oxidation, trans-fatty acids, and PUFA compared to corn/5% straw and 40% DG/5% straw. The treatments with the highest levels of WDGS (85% DG/10% straw) or straw (77.5% DG/17% straw) had the lowest color stability (lower L* values) and highest discoloration. There did not seem to be any changes to beef quality with added straw when high levels of WDGS are fed, but adding straw dramatically changed performance (Rich et al., *2011 Nebraska Beef Cattle Report,* pp. 84-86*)*.

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