A Comparison of Wheat and Corn-Based Distillers Grains Plus Solubles and their Combination on the Quality of Raw and Pre-Cooked *Semimembranosus* Roasts

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Abstract— **The objective of this study was to compare meat quality traits of raw and pre-cooked beef *semimembranosus* (SM) roasts from crossbred beef steers fed diets containing barley (control) or 40% wheat or corn dried distillers grains with solubles (DDGS) or their blend. Left inside rounds from 48 steers (12 per diet) were frozen for one year before testing. A portion of each SM was injected with a salt/phosphate brine (20% extension to deliver 0.85% sodium chloride and 0.40% sodium tripolyphosphate). Injected and non-injected roasts were cooked in a water bath (72°C). Proximate, pH, Warner-Bratzler (WB) shear, water holding and thiobarbituric acid reactive substances (TBARS) analyses were conducted over 56 d of storage (4°C).**

No dietary effects (P<0.05) were observed for meat quality, processing attributes, or WB shear values of non-injected roasts. Injected roasts from animals fed corn DDGS had the lowest brine pickup and highest WB shear values.

Raw non-injected meat from steers fed a DDGS diet was less oxidatively stable, as determined using TBARS. Oxidative changes due to diet were mitigated in the cooked injected roasts due to the chelating effect of phosphate, which also lowered overall TBARS values. TBARS values of the pre-cooked SM roasts remained below levels where rancidity is normally detected over 56 days of refrigerated storage (4°C). Overall, feeding 40% wheat DDGS, 40% corn DDGS or their blend had no negative effects on meat quality of raw SM or value–added products such as pre-cooked enhanced roasts.

Keywords— **Semimembranosus, oxidation, distillers grains.**

I. INTRODUCTION

Currently, the market for convenience products is expanding; consequently, there is a growing demand for chuck and round cuts [1]. Numerous studies have been published regarding the effect of animal diet on the eating quality of beef [2,3,4,5]; however, most of these studies concentrated on the effect of diet on the table eating qualities of beef and neglect such effects on beef for further processing [6]. In particular, no work has been done examining the effects of feeding ethanol by-products, such as dried distillers grains plus solubles (DDGS), on beef for further processing. This is an important consideration because it has been documented that feeding cattle a DDGS diet increases polyunsaturated fatty acid levels in the *longissimus* muscle [7] and backfat [5]. Little research has been conducted on the impact of feeding DDGS to cattle on the quality of other primal cuts, such as the *semimembranosus*. Therefore, the objective of this study was to compare the meat quality traits of raw and pre-cooked beef roasts prepared from the *semimembranosus* muscle of crossbred beef steers fed wheat versus corn DDGS.

II. MATERIALS AND METHODS

Steers were fed one of four diets: the control diet was a standard barley-based finishing diet comprised of 87.8% barley, 6.5% barley silage, and 5.7% supplement (DM basis) and the other diets involved substitution of wheat, corn, or a 50:50 blend of wheat and corn DDGS for barley grain in the control diet (40% dietary DM). Forty-eight *semimembranosus* muscles (SM) (12 per treatment) from the left carcass side were randomly selected for value-added meat processing analysis on three different processing days. Samples were denuded, aged (14 d) and placed in frozen storage (1 year).

Roasts were divided into sections for analysis of raw non-injected roasts, raw injected roasts and cooked injected roasts. Brine was prepared to deliver 0.85% food grade salt and 0.40% sodium tripolyphosphate (STTP) into the meat at 20% extension. Injected roasts were intermittently tumbled

for 2h (20 min on, 10 min off). Percent pump, brine uptake, cook yield, yield over green, and purge loss was recorded during processing. Sections designated for cooking were vacuum packaged and cooked in an air-agitated water bath (75°C) to an internal temperature of 72°C.

Proximate analysis was conducted on raw non-injected and cooked roasts. Similarly, raw roasts were ground and underwent thiobarbituric acid reactive substances (TBARS) analysis on days 1 and 7 of dark storage (4°). Cooked meat was divided into three roasts, vacuum-packaged and stored (4°C) for TBARS, Warner Bratzler shear force (WBSF) and expressible moisture (EM) analysis on days 1, 28 and 56.

Data was analyzed using PROC MIXED option of SAS 9.2. TBARS, WBSF and EM data were analyzed using repeated measures, with diet and day as the main effects and day as the repeated measure using an ante-dependence covariance model. Processing trial and section were included as random effects, while section was also included as a covariate. The remaining data was analyzed as a one-way ANOVA, using diet as the main effect and processing trial as a random effect. Means were separated using Tukey-Kramer Highest Significant Difference. Significance and trends were declared at $P \leq 0.05$ and 0.10, respectively.

III. RESULTS AND DISCUSSION

In general, the type of diet had no effect (P>0.05) on the chemical composition of raw or cooked SM roasts obtained from steers fed various DDGS diets. However, cooked roasts had a higher pH than raw injected roasts, which, in turn, had a higher pH than raw non-injected roasts (5.9, 5.7 and 5.4, respectively).

Consistent with meat quality of the fresh meat, no dietary differences were observed in regards to the processing characteristics of the pre-cooked beef roasts (**Table 1**). Differences in pump percentage or brine uptake were not expected because processing conditions were established to ensure these parameters did not vary. As with pump percentage and brine uptake, differences were not observed in the cook yields of SM roasts obtained from steers fed various DDGS diets. This shows that feeding steers a DDGS diet has no effect on the water-holding capacity of the resulting SM roasts. However, the injected roasts did have a higher yield over green than the non-injected roasts (85.08 and 72.70%, respectively). Overall, low cook yields were observed in this experiment.

Table 1 Effect of diet on processing attributes of *semimembranosus* roasts obtained from steers (n = 48) fed various DDGS diets

	Treatment				SEM	Sign
		DDGS Diet				
(%)	Control	Corn	Wheat	Blend		Diet
Pump	20.02	20.0	20.0	20.0	0.03	0.68
Uptake	78.08	72.3	74.6	74.8	2.2	0.28
Yield Over Green						
Non-Injected	72.7	72.6	72.2	73.4	0.66	0.63
Injected	85.4	85.0	84.6	85.4	0.69	0.11

Raw SM obtained from steers fed a DDGS diet displayed a 50% increase in TBARS values compared to raw SM obtained from steers fed the control diet (**Table 2**). More importantly, mean TBARS values exceeded the acceptable threshold value (2.0 mg malondialdehyde per kg meat [9]) where rancid off-flavours are first perceived by trained sensory panelists. SM obtained from steers fed the control diet had significantly lower TBARS values than SM obtained from steers fed blend DDGS after 1 d storage; while, after 7 d of dark storage (4°C), SM obtained from steers fed the control diet had significantly lower TBARS values than SM obtained from steers fed any DDGS diet.

Similar to what was observed with the raw non-injected SM roasts, injected meat obtained from steers fed a DDGS diet tended (P=0.07) to have higher TBARS values than meat obtained from steers fed the control diet. Any dietary effect observed in raw non-injected SM was lessened by the addition of salt and phosphate in the brine. This is evident, with a 65% reduction in TBARS values between the raw non-injected roasts and the raw injected roasts (3.15 and 1.91, respectively) combined with decreased variation in raw injected TBARS values. In total, the average TBARS of raw injected SM muscles from steers fed a

Table 2 TBARS values of raw non-injected and injected *semimembranosus* roasts obtained from steers fed various DDGS diets

	Treatment				SEM	Day		SEM*	*P*-value		
		DDGS Diet									
	Control	Corn	Wheat	Blend		1	7		Diet	Day	Diet x Day
TBARS [1]											
Non-Injected	2.23[b]	3.32[a]	3.34[a]	3.72[a]	0.22	1.38	4.93	0.13	<0.01	<0.01	<0.01
Injected	1.6	1.98	1.95	2.09	0.14	0.54	3.28	0.09	0.07	<0.01	0.02

* Pooled SEM
[1] mg malondialdehyde per kilogram of beef

DDGS diet were 24% higher than that from the steers fed the control diet.

As was observed for the raw injected SM roasts, cooking the SM roasts and storing them for an extended period of time did not influence oxidative stability (P<0.1), although the TBARS values from the pre-cooked roasts prepared from the SM of steers fed DDGS diets were numerically higher than the TBARS values from the pre-cooked roasts prepared from the SM of steers fed the control diet (1.76 and 1.36, respectively). Not only was diet insignificant, but day was also insignificant (P<0.1), meaning that TBARS had not increased by 56 days of storage. This is likely due to the absence of air due to vacuum packaging, preventing the unsaturated fatty acids from reacting with reactive oxygen species to form free radicals.

In the present study, TBARS values are well below the limiting threshold for the acceptability of oxidized beef. This shows that the combination of brine injection with vacuum-packaging is sufficient to maintain beef quality over 56 d of refrigerated vacuum-packaged storage, even in meat with elevated levels of polyunsaturated fatty acids [7].

Brine injection resulted in a 50% reduction in overall WBSF values compared to non-treated steaks (42 and 96 N, respectively; **Table 3**). The significant improvement in overall shear force values of SM following injection with a salt/phosphate brine is in agreement with results reported by many others [1,8].

From a dietary standpoint, no tenderness differences were detected in the non-injected SM roasts. Although there were large numerical differences in the non-injected WBSF values, there was too much variability for significance to be detected. However, injection with a salt / phosphate brine lowered the variability, resulting in dietary differences in WBSF. Specifically, pre-cooked beef roasts prepared from the SM of steers fed corn DDGS were less tender (higher shear values; P>0.05) than pre-cooked beef roasts prepared from the SM of steers fed blend DDGS (45.55 and 40.62, respectively), with pre-cooked roasts prepared from the SM of steers fed wheat DDGS and control displaying intermediate values (42.23 and 42.31, respectively). It is not clear why differences in tenderness were observed because there is no difference in overall moisture content or purge loss; however, meat obtained from steers fed corn DDGS had lower expressible moisture values than meat obtained from steers fed control or blend DDGS (11.92, 13.27 and 13.64%, respectively).

Table 3. Effect of diet on shear (WBSF) and expressible moisture (EM) of non-injected and injected pre-cooked *semimembranosus* roasts obtained from steers (n = 48) fed various DDGS diets.

	Treatment				SEM	Sign.
		DDGS Diet				
	Control	Corn	Wheat	Blend		Diet
Non-Injected						
WBSF	92.4	99.9	90.79	99.6	4.43	0.34
Injected						
WBSF	42.3[ab]	45.6[a]	41.2[ab]	40.6[b]	1.33	0.04
EM	13.3[a]	11.9[b]	12.8[ab]	13.6[a]	0.56	<0.01

IV. CONCLUSIONS

In summary, no differences were observed for meat quality, processing attributes, or tenderness of the non-injected SM roasts due to feeding of distillers grains from wheat or corn. Diet did have an effect on the tenderness of the injected SM roasts, with pre-cooked roasts prepared from the SM of steers fed corn DDGS having higher WBSF values than pre-cooked roasts prepared from the SM of steers fed blend DDGS. This is most likely due to the roasts prepared from the SM of steers fed corn DDGS having retained less moisture, as was shown with lower expressible moisture values, than roasts prepared from the SM of steers fed blend DDGS and control.

TBARS analysis of the raw non-injected SM showed meat obtained from steers fed a DDGS diet was less oxidatively stable than meat obtained from steers fed the control diet. This was likely caused by higher levels of unsaturated fatty acids in the meat from steers fed a DDGS diet having than that from steers fed the control diet. Not only were these dietary effects mitigated with the injection of a salt / phosphate brine, but overall TBARS values were lowered due to the antioxidant effect of phosphates. Likewise, cooking and subsequent refrigerated vacuum-packaged storage maintained oxidative stability of pre-cooked SM roasts below levels where rancidity is normally detected over a period of 56 d.

Overall, feeding 40% wheat DDGS, 40% corn DDGS or their blend did not significantly affect meat quality, processing characteristics or oxidative stability of enhanced roasts. Likewise, feeding wheat or blend DDGS did not affect any tenderness parameters; however, feeding corn DDGS resulted in meat with the highest WBSF.

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