Influence of feeding various levels of wet and dry distillers grains to yearling steers on carcass characteristics, meat quality, fatty acid profile and retail case life of *longissimus* muscle

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STORY IN BRIEF

Due to increased production of ethanol, abundance of distillers grains is on the rise. The objective was to determine the effects of wet (WDG) or dry (DDG) distillers grains on meat product quality. Yearling steers (n = 176) were assigned to one of five treatment groups: steam flaked corn (SFC), 10% DDG, 10% WDG, 20% WDG or 30% WDG. One-inch steaks were cut from strip loins and identified for simulated retail display, Warner-Bratzler shear force (WBSF) analysis, sensory panel determination, and fatty acid composition. Treatment had no effect on adjusted fat thickness and USDA yield and quality grades. Steaks from cattle fed 30% WDG had lower WBSF values than steaks from cattle fed 20% WDG. Trained sensory panelists found no differences in overall tenderness and off-flavors. No effects were found in total saturated and monounsaturated fatty acid composition among treatments, however, 20% WDG had a higher proportion of polyunsaturated and n-6 fatty acids. Data suggest that feeding WDG at higher levels (20% or 30%) does not diminish eating quality, but shelf life of strip loin steaks were negatively affected. Further research needs to be conducted to evaluate methods that aid in prolonging shelf life of steaks from cattle fed higher rates of WDG.

Key Words: beef steers, distillers grains, tenderness, fatty acids, carcass quality

INTRODUCTION

The abundance of distillers grains (DG) is on the rise due to the rapid increase in processing corn for ethanol production. Increased production in distiller's grains has led cattle feeders to consider DG as an optional feed source. In the southern Great Plains (Oklahoma, Texas and Western Colorado) the majority of feedlots feed steam-flaked corn (SFC) based rations. Data evaluating the use of wet distiller's grains (WDG) in SFC based feedlot rations is sparse. O'Sullivan et al. (2002 and 2003) showed that the feeding regimen of an animal can affect meat color and quality. Therefore, ration formulation may adversely affect meat quality, composition and ultimately shelf life. The objectives of this experiment were to determine the effects of feeding various levels of WDG, or DDG on carcass characteristics, meat quality, retail case life and fatty acid composition of *Longissimus* muscle.

MATERIALS AND METHODS

Cattle and Treatment. Yearling steers (n = 179) were delivered to Oklahoma State University Research and Extension Center/Oklahoma Panhandle State University feedlot near Goodwell, Oklahoma in early April, 2007. Steers were blocked by initial weight and allocated into one of thirty pens with six head per pen. Treatments were deemed as: SFC, 10% WDG, 10% DDG, 20% WDG, and 30% WDG. Based on visual appraisal, cattle were sent to a commercial harvest facility when the block was expected to have sufficient finish to grade 65% USDA Choice. Final individual body weights were recorded the morning of shipment.

Harvest and Data Collection. Steers were harvested at a commercial processing facility in Dodge City, KS. Trained Oklahoma State University (OSU) personnel completed tag transfer and obtained carcass measurements. Liver scores were also recorded, using the scale 1 = condemned and 0 = not condemned. Measurements included hot carcass weight (HCW), ribeye area (REA), marbling score, percentage of kidney, pelvic, and heart (KPH) fat, fat thickness, and USDA Quality Grade.

Strip Loin Collection and Sample Preparation. Following data collection, strip loins were tagged to maintain identity during fabrication. Strip loins were collected, vacuum packaged, and transported back to OSU Robert M. Kerr Food and Agricultural Products Center. Strip loins were aged 14 days postmortem at 35.6°F. After aging, the anterior end of the strip loin was faced and a sample was obtained for fatty acid profiling. Strip loins were cut into 1.0 inch thick steaks and labeled for simulated retail display, shear force and taste panel analysis.

Simulated Retail Display. Steaks labeled for retail display were placed on a styrofoam tray and over-wrapped with a polyvinyl chloride film (PVC). Trays were placed into a coffin style display case which was maintained at 35.6°F ± 1°F, under constant light conditions (Phillips Delux Warm White Florescent lamps). The surface of the meat was exposed to (900 to 1365 lux) as recommended by AMSA (1991). Each steak was objectively and subjectively evaluated for color attributes at 12h intervals during retail display for 7 days.

Objective and Subjective Color Evaluation. Color of each steak was measured using a HunterLab Miniscan XE hand-held spectrophotometer (Hunter Laboratory Associates, Inc., Reston, VA) to determine L* (brightness: 0 = black, 100 = white), a* (redness/greenness: positive values = red, negative values = green), and b* (yellowness/blueness: positive values = yellow, negative values = blue). Three readings were obtained for each steak, and were averaged to obtain the final L*, a*, b* values for each steak at each time of evaluation. Subjective color was evaluated by a six-person, trained panel of OSU personnel. Panelists assigned scores to each steak for muscle color, surface discoloration, and overall appearance at every evaluation time. Panelists characterized meat color (8 = extremely bright cherry red, to 1 = extremely dark red), surface discoloration (7 = no discoloration [0%], to 1 = total discoloration [100%]), and overall appearance (8 = extremely desirable, to 1 = extremely undesirable).

Fatty Acid Profiling. Steaks for fatty acid analysis were trimmed of all subcutaneous fat, cubed, frozen in liquid nitrogen, and pulverized in a waring blender to a powder-like consistency. Fatty acid methyl ester procedure was determined by gas chromatography as described by Bligh and Dyer (1959). Identification of the fatty acids were made by comparing the relative retention times of fatty acid methyl ester peaks from samples with those of a standard. Methyl ester peaks from samples were calculated as percentages of called fatty acids.

Objective Tenderness Determination. Steaks were allowed to temper at 39.2°F for 24h. Steaks were cooked on an impingement oven (model 1132-000-A; Lincoln Impinger, Fort Wayne, IN) at 356°F to an internal temperature of 158°F. Following cooking, steaks are allowed to cool for 24h before conducting shear force analysis. Six cores were taken from each steak parallel to muscle fiber orientation. Each core was sheared once with the Warner-Bratzler head on the Instron Universal Testing Machine (model 4502; Instron Corp., Canton, MA). Peak force (kg) of cores was recorded and mean peak WBSF was then calculated by averaging the 6 cores.

Palatability Determination. Steaks were allowed to temper 24 h prior to each session and were then cooked as described above for WBSF analysis. After cooking, samples were uniformly cut into 1 x 1 inch cubes and placed in a cup with a corresponding randomized number. The sensory panel consisted of eight trained OSU personnel. Samples were evaluated using a standard ballot from the American Meat Science Association (AMSA, 1995). The ballot consisted of a numerical, eight-point scale for initial and sustained juiciness (8 = extremely juicy, 1 = extremely dry), tenderness (8 = extremely tender, 1 = extremely tough), and connective tissue amount (8 = none, 1 = abundant). The flavor intensity of beef, painty/fishy and livery was scored on a three-point scale (1 = not detectable, 3 = strongly detectable).

Statistical Analysis. Data were analyzed using the mixed procedure of SAS. The analysis of variance of model for WBSF, sensory, and fatty acid analysis included treatment as the fixed effect and identification number as the random effect. The analysis of variance model for color attributes were analyzed using a repeated measures model with time as the repeated measure, identification number as the subject and treatment as the fixed effect. When the model was significant ($\alpha = 0.05$), least-square means were calculated and separated using pre-planned contrasts (SFC vs. DG, 10% DDG vs. 10% WDG, 10% WDG vs. 20% WDG vs. 30% WDG, and WDG vs. DDG).

RESULTS AND DISCUSSION

Carcass Data. The effects of dietary treatment on carcass characteristics are presented in Table 1. Carcasses from steers fed DDG had a higher ($P < 0.05$) marbling score ($Sm^{16} \pm 11.8$) than carcasses from steers fed WDG($Sl^{86} \pm 6.7$). Carcasses of steers fed 20% WDG tended ($P = 0.09$) to have a smaller ribeye area than 10% WDG (13.6 vs. 14.6 sq. in., respectively). Steers fed 30% WDG tended ($P = 0.06$) to have lower marbling scores than 10% WDG (Sl^{79} vs. Sm^{00}, respectively). No differences in treatment ($P > 0.05$) were found in adjusted fat thickness, and USDA yield grade.

Table 1. Least squares means ± SEM and main contrasts for carcass data

Treatments[1]	Adj. fat thickness, in.	Ribeye area, sq. in.	Marbling score[2]	USDA yield grade
SFC	0.53 ± 0.30	14.42 ± 0.34	382.94 ± 11.63	3.1 ± 0.17
10% DDG	0.50 ± 0.30	14.05 ± 0.34	416.76 ± 11.63	3.1 ± 0.17
10% WDG	0.51 ± 0.29	14.62 ± 0.33	400.00 ± 11.30	2.9 ± 0.16
20% WDG	0.54 ± 0.29	13.59 ± 0.33	381.11 ± 11.30	3.3 ± 0.16
30% WDG	0.53 ± 0.30	13.71 ± 0.34	379.43 ± 11.46	3.3 ± 0.16
Main contrasts[1]		*P*-values		

Wet vs. dry	0.40	0.84	0.03	0.88
SFC vs. DG	0.74	0.40	0.40	0.88
10% W vs. 10% D	0.78	0.27	0.40	0.35
% DG	0.54	0.09	0.06	0.23

[1] Treatments: SFC = steam flaked corn, D = dry, W = wet, DG = distillers grains.
[2] Marbling: 100 = practically devoid^{00}, 200 = traces^{00}, 300 = slight^{00}, 400 = small^{00}, 500 = modest^{00}, 600 = moderate^{00}.

Color Evaluation. The main effect of dietary treatment on subjective evaluation values at 48 h of simulated retail display (time at which 75% of steaks being evaluated were deemed moderately undesirable) are presented in Table 2. When comparing color scores from 10% WDG and 10% DDG, steaks from both treatment groups had a moderately dark cherry red color at 48 h. Furthermore, steaks from 10% DDG carcasses had a greater percentage of surface discoloration ($P < 0.05$), which resulted in those steaks being scored as very undesirable, while 10% WDG steaks were deemed as moderately undesirable ($P < 0.05$, Table 2). Steaks from cattle fed 10% and 20% WDG had higher ($P < 0.05$) b* values, which indicates more yellowness, than 30% WDG (Figure 1). Furthermore, L* and a* values were not significantly different.

Table 2. Least squares means ± SEM and main contrasts for subjective color evaluation of strip loin steaks for muscle color, surface discoloration and overall appearance

Treatments[1]	Muscle color[2]	Surface discoloration[3]	Overall acceptability[4]
SFC	3.97 ± 0.20	3.60 ± 0.27	3.28 ± 0.22
10% DDG	3.63 ± 0.20	4.25 ± 0.27	2.59 ± 0.22
10% WDG	3.59 ± 0.19	3.54 ± 0.26	3.20 ± 0.21
20% WDG	3.81 ± 0.19	4.06 ± 0.27	2.85 ± 0.22
30% WDG	3.56 ± 0.19	4.23 ± 0.26	2.75 ± 0.21
Main Contrasts[1]		*P*-values	
Wet vs. dry	0.51	0.33	0.18
SFC vs. DG	0.30	0.17	0.08
10% W vs. 10% D	0.17	0.04	0.03
% DG	0.56	0.84	0.56

[1] Treatments: SFC = steam flaked corn, D = dry, W = wet, DG = distillers grains.
[2] Muscle color: 1 = extremely dark red, 8 = extremely bright cherry red.
[3] Surface discoloration: 1 = no discoloration, 7 = total discoloration.
[4] Overall acceptability: 1 = extremely undesirable, 8 = extremely desirable.

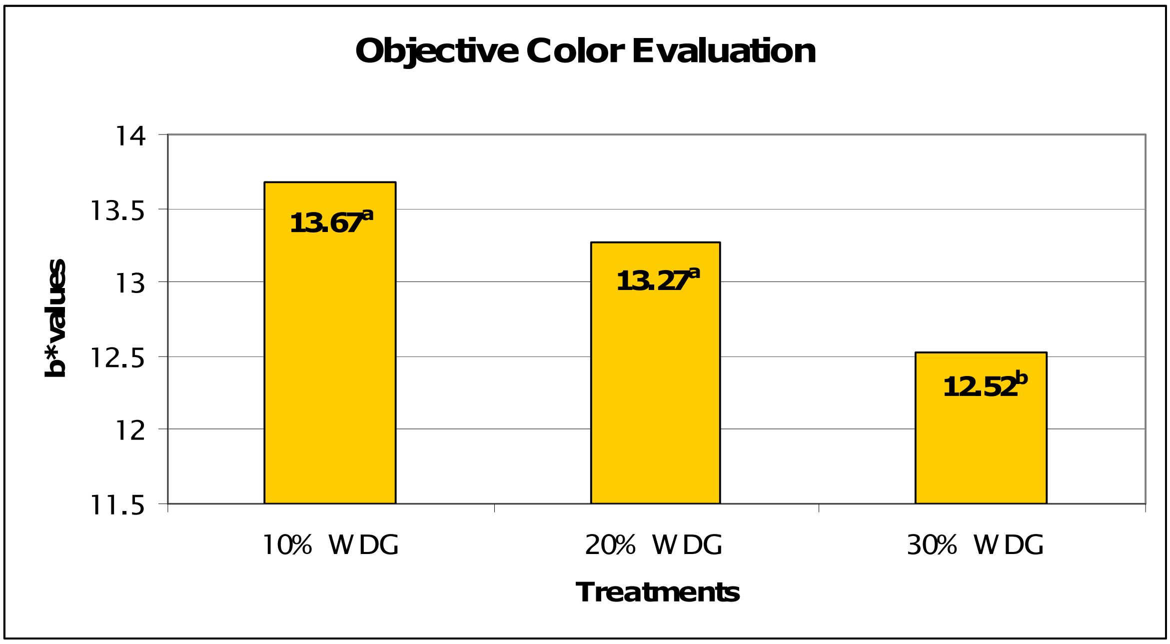

Figure 1. Objective color evaluation of strip loin steaks under retail display. Least squares means with the same letter are not different ($P > 0.05$).

Tenderness and Sensory Attributes. Warner-Bratzler shear force values indicated that no differences among the control and distillers diets were observed. However, when comparing strip loin steaks from cattle fed various percentages of WDG (Figure 2), steaks from steers fed 30% WDG and 10% WDG had lower ($P < 0.05$) Warner-Bratzler shear force (3.83 ± 0.13 kg and 4.13 ± 0.13 kg) values than 20% WDG (4.33 ± 0.13 kg,). Overall tenderness determined by a trained sensory panel verified WBSF results as panelists found no differences among treatments.

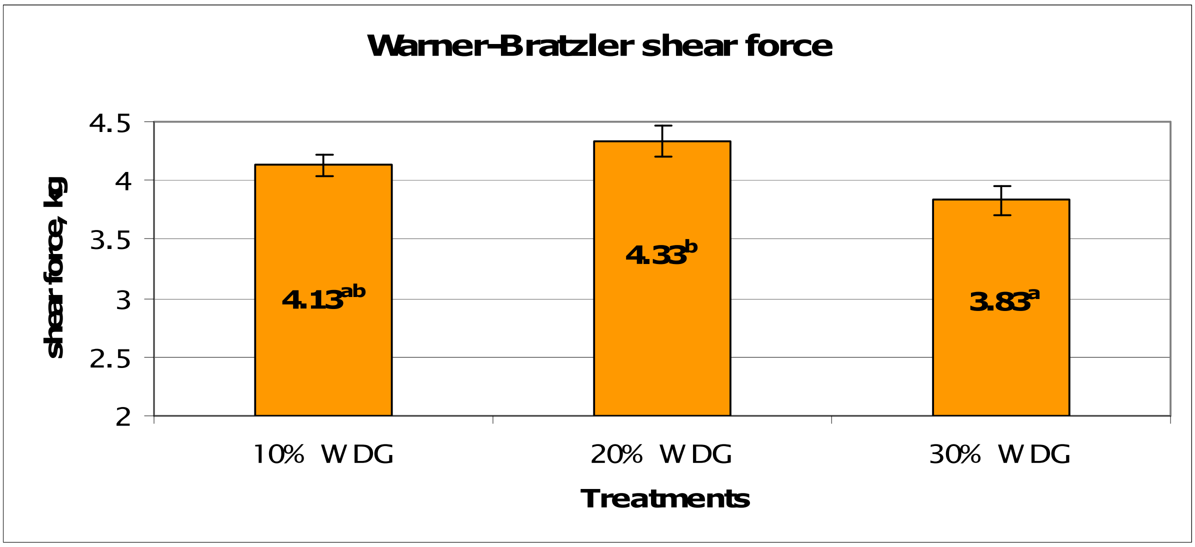

Figure 2. Warner-Bratzler shear force analysis of strip loin steaks from varying percentages of WDG. Least squares means with the same letter are not different ($P > 0.05$).

Fatty Acid Analysis. No differences were found in total saturated fatty acids (SFA), or total monounsaturated fatty acids (MUFA). Comparing steaks from cattle fed varying percentages of WDG demonstrated that the *longissimus* muscle (LM) from cattle fed 20% and 30% WDG were higher ($P < 0.05$) in polyunsaturated fatty acids (PUFA) than cattle fed 10% WDG (Figure 3).

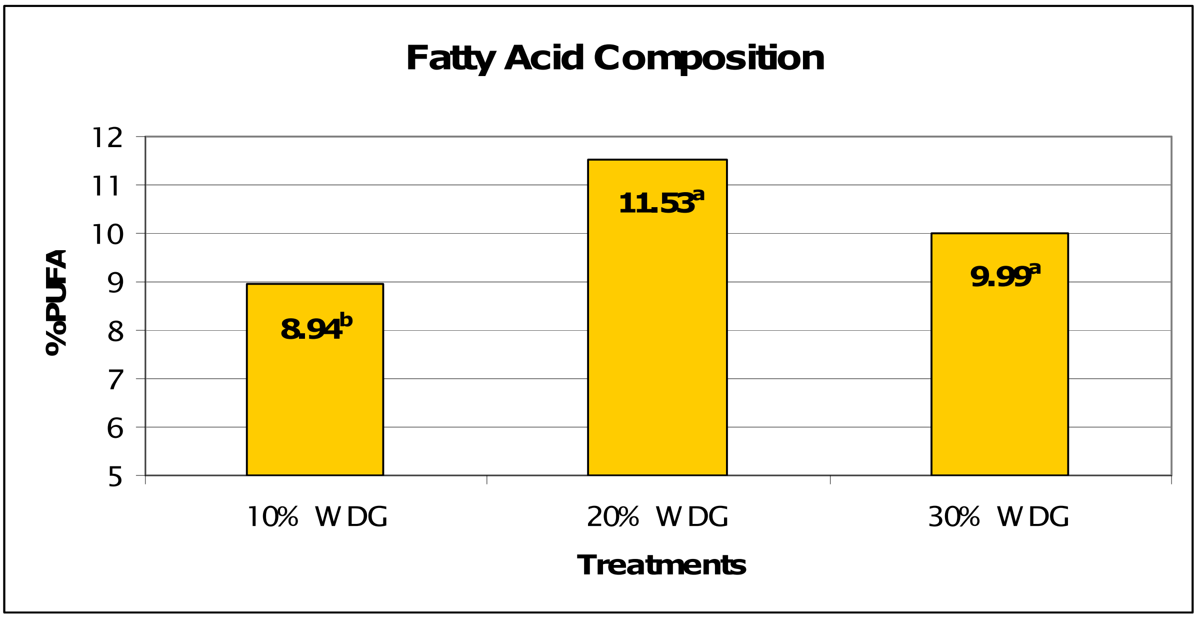

Figure 3. Total polyunsaturated fatty acid composition of strip loin steaks from varying percentages of WDG. Least squares means with the same letter are not different ($P > 0.05$).

CONCLUSION

Based on the results from this study, feeding various levels of WDG or DDG to cattle will not affect carcass characteristics or sensory attributes. Cattle producers are able to save money by replacing a percentage of SFG with DG in feed rations without causing detrimental affects to product quality. Data demonstrated that adding DG at 20% or 30% does not negatively affect sensory attributes. Beef from cattle fed 20% or 30% WDG will tend to have higher proportions of polyunsaturated fatty acids and therefore be more susceptible to oxidation resulting in a shortened shelf life. Further research should be done to evaluate different processing techniques to aid in increasing the shelf life of steaks from cattle fed higher inclusion rates of WDG.

LITERATURE CITED

AMSA. 1991. Guidelines for Meat Color Evaluation. Proceedings of the Reciprocal Meat Conference. Vol. 44.

AMSA 1995. Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Pg. 16-28.

Bligh, E. G. and W. J. Dyer. 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol. 37:911-917.

O'Sullivan, A., K. Galvin, A. P. Moloney, D. J. Troy, K. O'Sullivan, and J. P. Kerry. 2003. Effect of pre-slaughter ratios of forages and or concentrates on the composition and quality of retail packaged beef. Meat Sci. 63:279-286.

O'Sullivan, A., K. O'Sullivan, K. Galvin, A. P. Moloney, D. J. Troy, and J. P. Kerry. 2002. Grass silage versus maize silage effects on retail packaged beef quality. J. Anim. Sci. 80:1556-1563.