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WET DISTILLERS GRAINS PLUS SOLUBLES DOES NOT INCREASE LIVER-LIKE OFF-FLAVORS IN COOKED BEEF

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Introduction

Feed and supplementation costs account for 40-70% of total production costs in the beef industry (Funston, 1998). One viable option to lower production costs while still producing a high yielding, desirable product is to utilize distillers grains or distillers grains plus solubles. Distillers grains, the by-products of dry milling processes, offer a low cost and effective protein and energy source that is currently used in feedlot rations (Stock, Lewis, Klopfenstein, and Milton 2000). Wet distillers grains have been shown to increase daily gain and gain/feed when compared to dry-rolled corn and may help control subacute acidosis (Stock et al., 2000).

Results from the Beef Customer Satisfaction Study demonstrate the importance of flavor in relation to consumer acceptance (Lorenzen et al., 1999; Neely et al., 1999; Savell et al., 1999). Recently, purveyors, retailers, and consumers have reported a liverlike off-flavor in beef cuts. Miller (2001) noted that cuts cooked to higher degree of doneness, cuts with higher levels of myoglobin, and cuts with greater degrees of lipid oxidation typically express a liver-like off-flavor. More specifically, Yancey (2002) identified thirteen compounds that were higher in samples with liver-like off-flavor when compared to samples without liver-like flavors. Of these byproducts, six were aldehydes formed from the oxidation of oleic and linoleic acid.

Distillers grains supplementation increases unsaturated fat content of the diet which can subsequently escape rumen biohydrogenation and become incorporated into the phospholipid fraction of muscle tissue (Koger et al., 2004), thus increasing the possibility of lipid oxidation and subsequent off-flavors.

Objectives

Our objectives were to determine if feeding wet distillers grains plus solubles (WDGS) increases liver-like off-flavors in beef, and to determine the sensory attributes of cattle finished with WDGS.

Methodology

Cattle from this study were a subset of the cattle described by Vander Pol, Erickson, Klopfenstein, and Greenquist (2005). Briefly, two hundred eighty-eight crossbred yearling steers were randomly assigned to a dietary treatment containing 0, 10, 20, 30, 40, or 50% (DM basis) WDGS, where WDGS replaced a high-moisture/dry-rolled corn mixture (1:1 DM basis). Steers were implanted on d 28 with Revalor-S®, fed for 125 d and then harvested at a commercial processing facility. At harvest, university personnel randomly selected 15 Choice and 15 Select carcasses from each treatment group. Carcass data (hot carcass weight, fat thickness, and ribeye area) were collected by university personnel while USDA marbling score and yield grade were determined by a USDA grader. Following grading, the knuckles (IMPS #167) were removed from the carcasses, vacuum-packaged, and shipped to the Loeffel Meat Laboratory at the University of Nebraska.

Following the 7 d aging period at 1°C , the *M. rectus femoris* (knuckle centers) were isolated and cut into 2.54 cm steaks, freezer wrapped, and frozen (-16°C) until sensory analysis was conducted. Steaks were allowed to thaw in a cooler at 1°C for 1 d prior to cooking for sensory evaluation.

Sensory Evaluation

Steaks were cooked to an internal temperature of 70°C on an electric broiler (FSR200, Farberware Inc., Porspect, IL). Internal temperature was monitored with a digital thermometer (Omega Engineering, model 450-ATT, Stamford,CT) with a type T thermocouple (Omega Engineering, Stamford, CT). Once the internal temperature reached 35°C, the steak was turned once until the final temperature was reached. The steak was then cut into 1.27 cm x 1.27 cm x 2.54 cm cubes and served warm to the panelists, approximately 5 minutes post cooking.

Panelists for this study were selected and trained according to the guidelines and procedures outlined by Meilgaard, Civille, and Carr (1991). In order to prevent bias, panelists were seated in individual booths equipped with red fluorescent lights and partitioned to reduce collaboration between panelists and eliminate visual differences (Meilgaard et al., 1991). Each panelist was served distilled water and unsalted, saltine crackers and given three minutes between samples to cleanse their palates. Six samples, identified using three-digit codes, were served on each day. Eight-point descriptive attribute scales (Muscle fiber tenderness: 1=extremely tough, 8=extremely tender; Connective tissue: 1=abundant, 8=none; Juiciness: 1=extremely dry, 8=extremely juicy; Off-flavor intensity: 1=extreme off-flavor, 8=no off-flavor) were used. Panelists were trained to identify the specific off-flavors (liver-like, metallic, sour, charred, oxidized, rancid, or other) contributing to the off-flavor score for the steak.

Statistical Analysis

Data were analyzed as a randomized complete block design by analysis of variance (ANOVA) using the MIXED procedure of SAS (Version 9.1, Cary, N.C, 2002) with a predetermined significance level of $P \leq 0.05$. Carcass served as the experimental unit and was considered a random effect. Main effects of treatment, grade, and their two-way interaction were included in the model. Since the treatment x grade interaction was not significant for any attribute, least square means were not reported. The Kenward-Roger option was used to determine denominator degrees of freedom. When significance was indicated by ANOVA, means separations were performed using the LSMEANS and PDIFF function of SAS.

Results & Discussion

Carcass Data

A complete analysis of performance data from cattle sampled for this study has been reported by Vander Pol et al. (2005). Carcass data are presented here to characterize the meat source utilized in this trial. Results are consistent among the two analyses. Treatment had an effect on hot carcass weight and USDA yield grade (P=0.0001 and 0.036, respectively). Cattle finished on the 0%, 10%, and 50% diets had similar hot carcass weights, which were lighter than those from cattle fed 20%, 30%, and 40% diets (Table 1). Carcasses that were finished with any level of WDGS had higher USDA yield grades, which was also reported by Koger et al. (2004). Adjusted fat thickness, ribeye area, and USDA marbling score were not (P=0.37, 0.08, and 0.31, respectively) different in the present study. Koger et al. (2004) reported that cattle finished with distillers grains had greater adjusted fat thickness than cattle finished with the control diet. Distillers grains have higher fat content than corn, which may contribute to higher yield grades.

Table 1. Least squares means for main effects for hot carcass weight, adjusted fat thickness, yield grade, and marbling score.

Effect	Hot Carcass Weight,kg	Adjusted Fat Thickness,cm	Ribeye Area,cm^2	USDA Yield Grade	USDA Marbling Score[a]
Treatment[b]	0.0001[c]	0.37[c]	0.08[c]	0.036[c]	0.31[c]
0	356.3[d]	1.12	82.47	2.4[d]	503
10	366.5[de]	1.31	82.09	2.7[e]	521
20	371.4[ef]	1.28	81.92	2.7[e]	494
30	378.0[f]	1.23	81.65	2.7[e]	508
40	381.4[f]	1.20	77.81	2.9[e]	504
50	361.1[de]	1.24	78.81	2.7[e]	503
SEM[g]	3.92	0.01	1.38	0.11	8.10
Quality Grade	0.72[c]	0.24[c]	0.95[c]	0.10[c]	0.0001[c]
Choice	368.92	1.26	80.76	2.76	564
Select	367.78	1.20	80.82	2.61	465
SEM[g]	2.26	0.04	0.80	0.06	4.68

[a]400= Slight$_{00}$ and 500= Small$_{00}$.
[b]Treatments: Percentage of wet distillers grains plus solubles included in diet.
[c]*P*-value from analysis of variance tables.
[def]Mean values within a column and followed by the same letter are not significantly different (P>0.05).
[g] Standard error of the mean.

Sensory Analysis

Treatment had no effect on the sensory attributes muscle fiber tenderness, connective tissue amount, juiciness, and off-flavor intensity (Table 2). Gill, Roeber, and DiCostanzo

(2004) also reported that finishing cattle with distillers grains had no effect on taste panel tenderness, flavor, or juiciness.

USDA Choice steaks were more tender, had less amounts of detectable connective tissue, were juicer, and had a greater off-flavor intensity when compared to Select steaks. Our findings are consistent to those of Smith et al. (1987), who reported that Choice carcasses were more tender and more juicy than USDA Good steaks. Although off-flavor intensity was not recorded, Smith et al. (1987) reported that flavor and overall palatability scores for USDA Choice steaks were greater when compared to USDA Good steaks.

Treatment did not significantly influence off-flavor intensity (Table 3), although the frequency of liver-like off-flavor notes was approaching significance (*P*=0.07). The liver-like off-flavor occurred most frequently in the 0% and 10% WDGS diets (14.44 and 19.63, respectively) while steaks from animals fed the 30% or 50% WDGS diets had the lowest incidence of liver-like off-flavor (7.41 and 8.52, respectively). Liver-like and metallic off-flavors were more frequent in Select carcasses (*P*=0.02 and *P*=0.0002, respectively). Although oxidative rancidity was not measured in our study, we hypothesize that the increase in off-flavor intensity, liver-like, and metallic off-flavors is due to lipid oxidation. Vipond, Lewis, Horgan, and Noble (1994) and Koger et al. (2004) indicated that animals finished with distillers grains had significantly higher amounts of unsaturated fatty acids in muscle tissue. These unsaturated fatty acids can catalyze lipid oxidation. Miller (2001) reported that as lipid oxidation progresses, off-flavors such as metallic and liver-like increase. Findings in our study indicate that a greater percentage of panelists detected the liver-like off-flavor (15.19 vs. 9.51) and the metallic off-flavor (39.26 vs. 26.17) in USDA Choice steaks when compared to USDA Select steaks. All other off-flavor notes were not significant in terms of quality grade

Table 2. Least squares means for main effects for muscle fiber tenderness, connective tissue amount, juiciness, and off-flavor intensity.

Effect	Muscle Fiber Tenderness[a]	Connective Tissue Amount[b]	Juiciness[c]	Off-Flavor Intensity[d]
Treatment[e]	0.37[f]	0.72[f]	0.46[f]	0.47[f]
0	5.80	4.86	5.18	5.72
10	5.62	4.73	5.04	5.49
20	5.82	4.91	5.24	5.69
30	5.51	4.65	4.90	5.74
40	5.53	4.67	4.96	5.54
50	5.60	4.73	5.05	5.73
SEM[g]	0.13	0.14	0.13	0.11
Quality Grade	0.0001[f]	0.0001[f]	0.0009[f]	0.0020[f]
Choice	5.90[i]	5.01[i]	5.24[i]	5.51[h]
Select	5.39[h]	4.51[h]	4.87[h]	5.80[i]
SEM[g]	0.07	0.08	0.08	0.07

[a]Muscle Fiber Tenderness: 1= Extremely Tough; 8= Extremely Tender.
[b]Connective Tissue Amount: 1= Abundant Amount; 8=No Connective Tissue.
[c]Juiciness: 1= Extremely Dry; 8= Extremely Juicy.

[d]Off-Flavor Intensity: 1=Extreme Off-Flavor; 8= No Off-Flavor.
[e]Treatments: Percentage of wet distillers grains plus solubles included in diet.
[f]*P*-value from analysis of variance tables.
[g]Standard error of the mean.
[hi]Mean values within a column and followed by the same letter are not significantly different (*P*>0.05).

Table 3. Least squares means for main effects for liver-like, metallic, sour, oxidized, rancid, and other off-flavors.

Effect	Liver-Like[a]	Metallic[a]	Sour[a]	Charred[a]	Oxidized[a]	Rancid[a]	Other[a]
Treatment[b]	0.07[c]	0.73[c]	0.82[c]	0.37[c]	0.21[c]	0.75[c]	0.10[c]
0	14.44	34.07	48.89	7.41	10.37	12.22	2.96
10	19.63	27.41	50.37	8.52	11.85	8.52	0.74
20	11.85	31.85	50.74	5.56	18.52	11.11	3.33
30	7.41	31.85	55.19	4.44	11.48	10.74	3.33
40	12.22	34.81	49.63	8.89	16.67	11.11	2.59
50	8.52	36.30	50.37	5.56	10.37`	11.36	4.82
SEM[d]	0.03	0.04	0.03	0.02	0.03	0.02	0.01
QG[e]	0.02[c]	0.0002[c]	0.65[c]	0.14[c]	0.30[c]	0.24[c]	0.12[c]
Choice	15.19[g]	39.26[g]	51.48	7.78	11.98	11.36	3.58
Select	9.51[f]	26.17[f]	50.25	5.68	14.44	9.38	2.35
SEM[d]	0.02	0.02	0.02	0.01	0.02	0.01	0.01

[a]Off-flavors are expressed as a percentage of panelists that identified the off-flavor.
[b]Treatments: Percentage of wet distillers grains plus solubles included in diet.
[c]*P*-value from analysis of variance tables.
[d]Standard error of the mean.
[e]Quality grade.
[fg]Mean values within a column and followed by the same letter are not significantly different (*P*>0.05).

Conclusions

Results from this study indicate that finishing cattle with wet distillers grains plus solubles does not cause the liver-like off-flavor or any other off-flavors in the *M. rectus femoris*. Wet distillers grains plus solubles offers cattle feeders cost effective means to finish cattle with minimal effects on meat palatability.

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