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Characteristics of Beef Finished on Wet Distillers Grains with Varying Types and Levels of Roughage

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Summary

Beef knuckles (n = 160) were obtained from source-verified cattle finished on 30% wet distillers grains plus solubles enriched with varying levels of alfalfa hay, corn silage, or corn stalks based on NDF. Our objectives were to determine if roughage inclusion, in conjunction with wet distillers grains plus solubles and cattle location affects beef flavor. Data from this study indicate type and level of roughage inclusion and cattle location have minimal effects on fatty acid profiles and sensory properties of the M. Rectus femoris. However, individual fatty acids of subcutaneous and intramuscular fat were significantly correlated with liver-like off flavor.

Introduction

Even with numerous feedlots in the Midwest finishing cattle on distillers grains, little research has been published on the effects of distillers grains on carcass quality. Recent research in our laboratory has concentrated on the effects of wet distillers grains plus solubles (**WDGS**) on meat quality. Specifically, we have shown that finishing cattle with 30% WDGS increases polyunsaturated fatty acids (**PUFA**) which in turn can comprise the color of some muscles under retail display. The objectives of this research were to investigate effects of varying roughage sources and types, in addition to cattle source, on meat quality characteristics of the *M. Rectus femoris* (**REC**) with particular interest in liver-like off flavor.

Procedure

Three hundred eighty-five crossbred steer calves of known birth ranch, approximately 7 months of age, were purchased from sale barns in South Dakota (**SD**) or Nebraska (**Neb.**), implanted with Syonvex-C, and grazed on corn stalks for 45 days prior to being placed in their respective feeding treatments. The steers were then weighed, implanted with Revalor-S, stratified to treatment by weight, and randomly assigned a pen. Cattle were on the finishing diets for 139 days. Dietary treatments included of a control, which contained a mixture of dry-rolled and high-moisture corn fed at a 1:1 ratio and 30% WDGS on a DM basis. Additionally, alfalfa hay was included in the diet at either 4% or 8% in addition to 30% WDGS. Diets containing low and high levels of both corn silage and corn stalks were balanced to provide equal levels of NDF based on the diets containing low and high amounts of alfalfa, respectively. This resulted in 6% or 12% corn silage and 3% or 6% corn stalks. For the final 28 days, all steers were supplemented (200 mg/steer) with Optaflexx. On day 140, cattle were harvested at a local commercial facility. Following grading, knuckles were removed, vacuum-packaged and shipped to the Loeffel Meat Laboratory at the University of Nebraska–Lincoln. After a 7-day aging period, the REC was isolated, cut into 1 in thick steaks, vacuum packaged, and frozen at -112°F until appropriate analyses could be conducted. The most proximal steak was minced, frozen in liquid nitrogen, pulverized, and used for chemical analysis while the most distal steak was used for trained sensory analysis.

Steaks were cooked to an internal temperature of 158°F on an electric broiler. Internal temperature was monitored with a digital thermometer and a type T thermocouple. When the internal temperature reached 95°F, the steak was turned once. The steak was then cut into 0.5 in x 0.5 in x 1.0 in cubes and served warm to 6-8 trained panelists, approximately 5 minutes post cooking. 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. Off-flavors were rated using a 15-point intensity scale (0 = extremely bland; 15 = extremely intense).

Moisture and ash (expressed as percentages) were quantified using a LECO Thermogravimetric Analyzer while percent fat was determined using an ether extraction method. Fatty acids were extracted using a 2:1 chloroform:methanol solution and methylated using boron fluoride-methanol. Oxidation-reduction potential (**ORP**) was determined using an epoxy body, gel filled ORP triode and thermocouple, while pH was determined using a Ross ultra glass combination pH electrode and a thermocouple.

An analysis of variance (**ANOVA**) using the MIXED procedure of SAS (Version 9.1, Cary, N.C., 2002) was used to analyze the data. When indicated significant by ANOVA ($P \leq 0.050$) main effects (treatment and source) were separated using the LSMEANS and DIFF, while simple effects of interactions were generated using the LSMEANS, and SLICE functions, respectively.

(Continued on next page)

Results

Chemical Data

Main effects (diet and location) were not statistically significant ($P \geq 0.129$) for proximate analysis and ORP, nor was the location effect for pH. A significant ($P = 0.012$) diet effect for pH was observed (Table 1). The pH values were in the range of what would be expected of 7-day aged beef (5.59 - 5.68). The control treatment was similar to the silage treatment (regardless of level) and to the low corn stalk treatment ($P \geq 0.253$). Finishing cattle on alfalfa (regardless of amount) resulted in significantly ($P \leq 0.033$) higher pH when compared to the control diet.

Subcutaneous Fatty Acids. Saturated fatty acid content of subcutaneous adipose tissue did not differ ($P \geq 0.084$) among diets or locations for 10:0, 12:0, 13:0, 14:0, 16:0, 18:0, 19:0, 20:0, and saturated fatty acids (**SFA**). Cattle from SD (45.74%) tended ($P = 0.065$) to contain more SFA when compared to cattle from Neb. (44.77%).

Minimal differences were noted for unsaturated fatty acids (**UFA**) profiles. No significant ($P \geq 0.128$) diet or location effects were noted for 14:1 (n-5), 16:1(n-7), 17:1(n-7), 18:1(n-9), *cis* 18:1(n-7), 20:1(n-9), 20:2(n-6), 20:3 (n-6), or 20:4(n-6). Diet tended ($P = 0.100$) to affect 18:2(n-6), in which cattle finished on corn silage (regardless of amount) had numerically greater levels when compared to cattle finished on the control, alfalfa, or corn stalks diets. No significant location effect was observed for 18:2(n-6) ($P = 0.439$). Trans fatty acids, conjugated linoleic acid (**CLA**), PUFA, and omega 6 fatty acid contents were not affected ($P \geq 0.112$) by diet or location. Additionally, dietary effects for monounsaturated fatty acids (MUFA) and PUFA were not different ($P \geq 0.304$). However, cattle from Neb. contained more MUFA ($P = 0.048$) and tended to contain more UFA ($P = 0.068$).

Intramuscular Fatty Acids. No significant ($P \geq 0.153$) diet or location effects (Table 2) were observed for 10:0, 12:0, 14:0, 15:0, iso 16:0, iso 18:0, 18:0, 19:0, 20:0 or SFA. Cattle from Neb. had more ($P = 0.049$) 13:0, but the dietary effect for 13:0 was not significant ($P = 0.477$). Location had no effect on 16:0 concentration ($P = 0.160$), but diet significantly ($P = 0.011$) affected 16:0 levels. Cattle finished on corn silage (regardless of level) and high amount of corn stalks had significantly lower levels of 16:0 when compared to the control. However, cattle finished on low amounts of corn stalks and alfalfa hay (regardless of level) were similar to the control. Significant ($P \leq 0.046$) dietary effects were observed for 18:1(n-9) and 18:2(n-6). Cattle finished on the low amounts of alfalfa and corn stalks had greater amounts of 18:1(n-9) when compared to the control, but had less 18:2(n-6) (Table 2). Additionally, cattle finished on low amounts of alfalfa had significantly ($P \leq 0.050$) lower levels of 20:4(n-6) and 22:5(n-3) when compared to the other treatments. Cattle from Neb. had significantly ($P = 0.020$) greater amounts of CLA when compared to S.D. cattle. Cattle finished on low amounts of alfalfa and corn stalks

Table 1. Least squares means for main effects for moisture, ash, pH, percent fat, and ORP.

Effect	Moisture	Ash	pH	Percent Fat	ORP[a]
Treatment[b]					
CONT	73.41	1.18	5.58[f]	5.02	538.79
LALF	73.41	1.20	5.65[cde]	5.47	534.84
HALF	73.27	1.16	5.66[cd]	5.19	523.63
LSTALK	73.80	1.17	5.62[def]	5.52	528.82
HSTALK	74.09	1.18	5.68[c]	4.76	533.82
LSIL	73.65	1.22	5.61[bcd]	4.52	532.55
HSIL	73.66	1.21	5.59[ef]	5.22	531.55
SEM	0.29	0.02	0.02	0.31	3.42
P > F	0.516	0.320	0.012	0.198	0.157
Location					
NE	73.57	1.20	5.63	5.12	533.26
SD	73.74	1.18	5.62	5.08	530.74
SEM	0.15	0.01	0.01	0.16	2.08
P > F	0.382	0.129	0.729	0.852	0.435

[a]Oxidation-reduction potential.
[b]Treatments: CONT = Control; LALF = Low Alfalfa; HALF = High Alfalfa; LSTALK = Low Corn Stalks; HSTALK = High Corn Stalks; LSIL = Low Corn Silage; HSIL = High Corn Silage.
[bcde] Mean values within a column and followed by the same letter are not significantly different ($P > 0.050$).

Table 2. Least square means for main effects of selected saturated fatty acids for intramuscular fat.[a]

Effect	16:0	18:1 (n-9)	18:2 (n-6)	20:4 (n-6)	22:5 (n-3)	MUFA[b]	PUFA[c]
Treatment[d]							
CONT	25.12[e]	29.85[fg]	6.19[ef]	1.18[e]	0.28[ef]	43.30[g]	9.17[ef]
LALF	24.59[e]	31.52[e]	5.50[f]	0.86[f]	0.21[g]	45.20[f]	7.98[f]
HALF	24.41[efg]	31.07[ef]	6.14[ef]	1.12[ef]	0.28[ef]	44.45[efg]	9.00[f]
LSTALK	24.59[e]	31.67[e]	5.66[f]	0.95[ef]	0.24[fg]	45.04[ef]	8.33[f]
HSTALK	23.83[g]	30.65[efg]	6.26[ef]	1.23[e]	0.28[ef]	43.85[fg]	9.16[ef]
LSIL	24.08[fg]	30.33[efg]	7.00[e]	1.23[e]	0.31[e]	43.89[efg]	9.98[e]
HSIL	24.10[fg]	29.46[g]	6.95[ef]	1.23[e]	0.28[ef]	43.61[g]	10.04[e]
SEM	0.28	0.58	0.39	0.10	0.02	0.51	0.51
P > F	0.011	0.044	0.046	0.050	0.018	0.040	0.039
Location							
NE	24.24	30.83	6.16	1.06	0.26	44.30	8.95
SD	24.54	30.47	6.32	1.16	0.27	44.08	9.23
SEM	0.15	0.29	0.02	0.06	0.01	0.26	0.25
P > F	0.837	0.374	0.571	0.215	0.301	0.536	0.415

[a]Fatty acids are expressed as percentage of total fatty acid methyl esters.
[b]Monounsaturated fatty acids.
[c]Polyunsaturated fatty acids.
[d]Treatments: CONT = Control; LALF = Low Alfalfa; HALF = High Alfalfa; LSTALK = Low Corn Stalks; HSTALK = High Corn Stalks; LSIL = Low Corn Silage; HSIL = High Corn Silage.
[efg]Values containing the same superscript within a column do not differ statistically ($P > 0.050$).

Table 3. Correlation coefficients between chemical attributes and the liver-like off flavor.

Attribute	r	P > F
18:2 9*t*,12*t*[a]	-0.17	0.037
20:1(n-9)[a]	0.21	0.001
CLA 9*c*,11*t*[a]	0.16	0.046
20:4(n-6)[a]	-0.14	0.088
22:4(n-6)[b]	-0.15	0.066
pH	0.14	0.076

[a]Subcutaneous adipose tissue.
[b]Intramsucular adipose tissue.

had the greatest amounts ($P < 0.050$) of MUFA, while cattle finished on corn silage (regardless of level) had the greatest amount ($P < 0.050$) of PUFA and omega 6 fatty acids (Table 2).

The mechanism for source effects is not quite understood. Since all the cattle were on the finishing trial for 139 days, these results suggest that the source differences in fatty acid profiles existed prior to entering the trial. Further research should be conducted to investigate the possible mechanisms.

Sensory Analysis. Significant diet effects were observed for muscle fiber tenderness ($P = 0.014$) and juiciness ($P = 0.002$) while connective tissue amount was approaching significance ($P = 0.068$). Cattle finished on low amounts of alfalfa and corn stalks were the most tender and most juicy when compared to the other diets. Additionally, these diets tended to have the least amount of detectable connective tissue which probably contributed to the increased tenderness of these treatments. No diet effect was noted for off-flavor intensity ($P = 0.819$). Location effects for muscle fiber tenderness, connective tissue amount, and off flavor intensity were not significant ($P \geq 0.241$). However, cattle from South Dakota were significantly juicer than cattle from Nebraska.
($P = 0.019$). No significant diet or location effects were observed for liver-like, metallic, sour, charred, or oxidized off-flavors ($P \geq 0.169$). However, cattle finished on low amounts of corn stalks had 3 times as many panelists indicate liver-like off flavor when compared to the other treatments. Significant diet ($P = 0.006$) and location ($P = 0.023$) effects were reported for bloody notes. Cattle finished on the low amounts of alfalfa most frequently had bloody off-flavor while cattle finished on the control, high amounts of alfalfa and corn stalks, and silage treatments had the lowest bloody notes. Additionally, cattle from South Dakota had higher bloody notes than cattle from Nebraska. Correlation coefficients between chemical attributes and the liver-like off flavor were calculated (Table 3). Subcutaneous levels of 18:2 9*t*,12*t* were inversely related with liver-like off flavor while subcutaneous levels of 20:1(n-9) and CLA 9*c*,11*t* were directly related. Although not quite statistically significant ($P = 0.076$) , pH tended to be directly related, while subcutaneous level of 20:4(n-6) and intramuscular levels 22:4(n-6) were indirectly related to the liver-like off flavor.

Implications

Data from this study indicated including roughage with WDGS had minimal effects on the sensory attributes of beef. However, including silage in the diet could increase the probability of oxidation due to increases in PUFA. Furthermore, PUFA, but not cattle source, played a significant role in the development of liver-like off flavor. Dietary manipulation of these fatty acids may prove beneficial in reducing the incidence of the liver-like off flavor.

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