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The Effect of Corn Distillers Dried Grain with Solubles (DDGS) on Carcass Characteristics and Pork Quality

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Dietary distillers dried grains with solubles (DDGS) inclusion decreased saturated fatty acid and increased unsaturated fatty acid concentrations in fat samples from growing-finishing pigs. Pork color, chemical composition, or sensory characteristics were not affected by DDGS.

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Summary

A study was conducted to evaluate the effect of feeding 0, 5, 10 or 15% distillers dried grains with solubles (DDGS) on carcass quality, color stability, and sensory characteristics of the longissimus muscle (LM) of finishing pigs. Live weight and hot carcass weight decreased as dietary DDGS increased ($P < 0.05$). Dressing percentage did not differ among treatments ($P = 0.72$). After 10 days of retail display, no differences were observed among treatments for color or color change ($P > 0.05$). No differences in shear force were observed ($P = 0.34$). Total unsaturated fatty acids increased and total saturated fatty acids decreased ($P < 0.05$) as dietary DDGS increased. Treatments did not affect sensory characteristics ($P > 0.05$). The results of this investigation suggest that dietary DDGS inclusion altered fatty acid profile of the backfat of pigs by reducing total saturated fatty acid and increasing total unsaturated fatty acid concentration. Increasing the concentration of dietary DDGS did not affect color, chemical composition, or sensory characteristics of the LM.

Introduction

The increased availability of corn distillers dried grain with solubles (DDGS) has resulted from the increase in ethanol production from corn. Research indicates that pork quality is influenced by the dietary ingredients used in growing-finishing pig diets, and there is evidence to suggest that DDGS affects carcass quality by reducing carcass weight and dressing percentage. Additionally, some investigators report that feeding DDGS results in softer carcasses due to increased unsaturated and decreased saturated fatty acid concentration in fat. From the consumer's point of view, pork color and absence of off-flavors are important traits; therefore, it is essential to evaluate the nutritional value of DDGS as well as its effect on sensory characteristics of pork. This report is a companion article to the previous article that reports the feeding value of diets for growing-finishing pigs with varying DDGS concentration. The objective of this study was to evaluate the effects of feeding varying concentrations of DDGS on carcass and sensory characteristics of pork.

Materials and Methods

Carcass data collection

Two hundred forty pigs weighing an average of 49.2 lb were assigned to one of four dietary treatments. Each treatment consisted of a standard diet in which a portion of dietary corn and soybean meal were replaced to include 0, 5, 10 or 15% of DDGS. Details of the growth study are described in a companion article. At the end of the feeding phase all pigs were transported to a commercial pork packing facility located approximately 30 miles from the University of Nebraska Swine Research

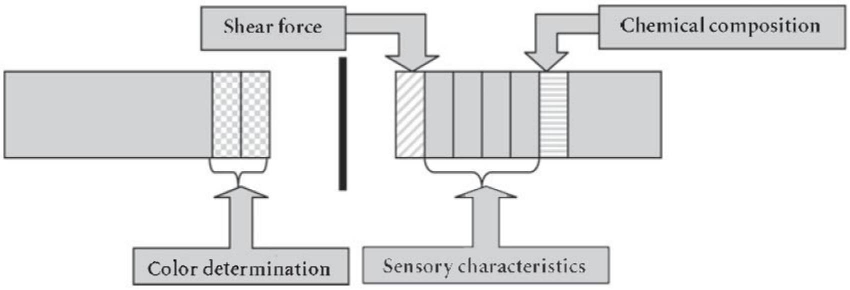

Figure 1. Longissimus muscle sections of the loins used for shear force, color determination, sensory characteristics, and chemical analysis

Table 1. Attribute, magnitude, and description and scale of sensory characteristics.

	Magnitude		
Attribute	0 mm	150 mm	Comments
Appearance	Very non-uniform	Very uniform	Color of interior meat
Toughness	Very tough	Very tender	During the first bite
Chewiness	Very hard to breakdown	Very easy to breakdown	During chewing
Juiciness	Very dry	Very moist	
Pork flavor	Lacking	Intense	
Off-flavor	Lacking	Intense	
Aftertaste pork flavor	Lacking	Intense	
Aftertaste off flavor	Lacking	Intense	
Overall acceptability	Very undesirable	Very desirable	

Unit. Pigs were weighed before entering (live weight; LW) and before leaving the harvesting floor (hot carcass weight; HCW). Dressing percentage (DP) was calculated using the following formula DP = ((LW / HCW)×100). Carcasses were subjected to a standard spray-chilling procedure for 24 hours. Before entering the fabrication floor, a cut was made on the right side of the carcasses between the 10th and 11th rib and the longissimus muscle (LM) was traced on acetate paper and area (LMA) was measured. Tenth-rib backfat depth (TRBF) and last-rib backfat depth (LRBF) were measured. A backfat sample was obtained perpendicular to the 10th rib, submerged in liquid nitrogen and maintained at -112°F until analyzed for fatty acid profile. Two pigs from each pen were randomly selected prior to harvesting, carcasses were identified on the chilling floor, marked in the vertebrae, and the loin (410 pork loin; NAMP, 1997) from the right side of the carcass was collected. The collected loins were individually vacuum-packed and transported to the Meat Science Laboratory at the University of Nebraska. Seven days post mortem, the loins were boned and a section of LM (412B pork loin, boneless, center-cut, eight ribs; NAMP, 1997) was removed and divided in two sections (Figure 1). A total of nine 1-inch sections were obtained for color determination, shear force estimation, sensory characteristics evaluation, and chemical composition.

Color determination

The two sections of the LM used for color determination were packed in Styrofoam trays, wrapped with PVC film, and maintained at 34°F under fluorescent light illumination for 10 days. Color spectrometry measurements L*, a*, and b* (representing lightness, redness, and yellowness respectively) were obtained through the packing film on five sites on each section at the beginning (day 0) of the 10 day-color trial and daily thereafter using a Hunter Lab® Mini Scan XE plus (Model 45/0-L, Reston, Va.) handheld colorimeter. The calibration of the colorimeter was performed daily using black and white tiles. The change in total color (E) was calculated as [((L* at d 10 – L* at d 0)^2 + (a* at d 10 – a* at d 0)^2 + (b* at d 10 – b* at d 0)^2)^{½}; Minolta, 1998]. This formula was developed in order to better describe the changes in color that would occur during periods of retail display.

Warner-Bratzler shear force analysis.

The loin sections used for Warner-Bratzel shear force (WBSF; AMSA, 1995) were vacuum-packed and maintained at -4°F until analysis. Before the analysis chops were allowed to thaw, cooked to an internal temperature of 158°F on a Hamilton Beach Grill (Washington, N.C.), and cooled for 4 hours at 35.6°F. During the cooking process, temperature was monitored using thermocouples. Three cores of 0.5 in^2 from each section were removed parallel to the arrangement of the muscle fiber. Cores were sheared parallel to the muscle fiber using an Intron Universal Testing Machine (Model 55R1123, Canton, Mass.) equipped with a Warner-Bratzler shear attachment. The speed for the test was 250 mm/minute.

Fatty acid profile

Fat samples were extracted in hexane and methyl esters were formed. The mass ratio of fatty acids were quantified using a gas chromatograph (Heweltt-Packard, Model 5890, Farmington Hills, Mich.).

Sensory evaluation

Chops were cooked and sensory evaluation was conducted using 40 consumer panelists recruited from the Animal Science Department and the Department of Food Science and Technology at the University of Nebraska–Lincoln. The chops were cooked using an electric grill to an internal temperature of 158°F. Once cooked, chops were trimmed of excess fat. Samples of 1 in^2 were obtained and maintained warm until served to the panelists. A descriptive scale was used to determine the effect of DDGS inclusion on pork quality and flavor. Panelists used an unstructured line-scale to evaluate the attributes provided in Table 1.

(Continued on next page)

Table 2. Response and significance of dietary DDGS[a] inclusion on final weight and carcass characteristics of growing-finishing pigs.

	DDGS[a], %					*P*-value		
Item	0	5	10	15	SEM[b]	Treatment	Linear	Quadratic
No. of pigs	13	11	12	11				
Live weight, lb	273.25	266.60	257.64	250.07	5.12	0.02	0.02	0.92
Hot carcass weight, lb	203.95	197.49	190.72	184.39	3.93	0.01	0.01	0.98
Dressing, %	74.64	74.10	74.02	73.72	0.57	0.72	0.28	0.83
Last rib BF[c], in	1.04	0.99	0.98	0.94	0.28	0.14	0.02	0.94
10th rib BF, in	0.94	0.76	0.85	0.85	0.10	0.68	0.69	0.40
LMA[d], in^2	7.82	8.02	7.59	7.25	0.20	0.07	0.02	0.19

[a]DDGS = Corn distillers dried grain with solubles.
[b]SEM = Standard error of the mean
[c]BF = Backfat.
[d]LMA = Longissimus muscle area

Table 3. Response and significance of dietary [a]DDGS inclusion on the composition, shear force and color of the longissumus muscle of growing-finishing pigs.

	DDGS[a], %					*P*-value		
Item	0	5	10	15	SEM[b]	Treatment	Linear	Quadratic
Composition, %								
Crude protein	22.50	22.69	22.59	22.55	0.21	0.89	0.94	0.55
Moisture	71.90	71.31	70.73	72.23	0.50	0.17	0.84	0.04
Ash	1.12	1.14	1.18	1.16	0.02	0.32	0.11	0.41
Fat	3.87	4.12	4.86	3.04	0.49	0.08	0.38	0.03
Shear force, lb	6.7	7.03	6.37	6.92	0.28	0.34	0.99	0.66
Color (d 0)								
a*, (redness)	20.84	20.84	20.41	20.57	0.42	0.71	0.50	0.85
b*, (yellowness)	17.68	17.67	17.52	17.30	0.34	0.89	0.43	0.77
L*, (lightness)	54.31	54.07	54.72	54.49	0.43	0.84	0.75	0.99
Color (d 10)								
a*, (redness)	17.16	18.34	17.66	17.10	0.62	0.71	0.68	0.13
b*, (yellowness)	16.31	17.02	16.96	16.41	0.46	0.89	0.91	0.17
L*, (lightness)	54.08	55.14	55.91	56.07	0.72	0.84	0.22	0.97
E[c]	4.17	2.81	3.03	4.07	0.64	0.32	0.97	0.70

[a]DDGS = Corn distillers dried grain with solubles.
[b]SEM = Standard error of the mean.
[c]E = Change in color.

Statistical analysis

Carcass characteristics, chemical composition, fatty acid profile and sensory characteristics were analyzed as a complete randomized design using the MIXED procedure (SAS Inst. Inc., Cary, N.C.). Each pig was considered an experimental unit and pen was considered a random effect. Color data were analyzed as repeated measures in time using the MIXED procedure of SAS. Pig was considered the experimental unit and tray was considered a random effect.

Results and Discussion

Carcass traits are shown in Table 2. A negative linear response to DDGS concentration was recorded for LW and HCW ($P < 0.05$), which indicates that LW and HCW decreased as dietary DDGS increased. Dressing percentage was not affected ($P = 0.72$) by dietary DDGS. These results differ from those reported in other studies that showed reductions in DP as DDGS concentration increased. Treatments did not affect LMA, LRBF, and TRBF ($P > 0.05$).

The results of the chemical analysis and color of LM are provided in Table 3. Protein, moisture, fat, and ash were not affected by dietary DDGS inclusion ($P > 0.05$). Shear force did not differ among treatments ($P = 0.34$). At day 0 and 10 there was no difference among treatments ($P > 0.05$) for redness (a*), yellowness (b*), lightness (L*), and color change (E). These results indicate that during the 10-day experimental period, pigs receiving increasing dietary concentration of DDGS showed a pattern in change of color (E) similar to the control diet (0 % DDGS).

Table 4 shows the fatty acid profile of backfat samples. Mysistic, palmitoleic, stearic, oleic, vaccenic, and α-linolenic were not affected by dietary DDGS concentration ($P > 0.05$). Treatments affected palmitic acid concentration ($P = 0.03$) and exhibited a linear reduction in mass % as dietary DDGS inclusion increased ($P = 0.01$). Linoleic acid concentration was affected by treatment ($P = 0.01$); increasing dietary DDGS increased mass % of this fatty acid in backfat ($P = 0.01$). Despite the lack of significant treatment effect ($P = 0.06$), increasing the concentration

Table 4. Response and significance of dietary DDGS[a] inclusion on fatty acid profile of finishing pigs.

Item	DDGS[a], %				SEM[b]	*P*-value		
	0	5	10	15		Treatment	Linear	Quadratic
Fatty acid, mass %								
Myristic, (14:0)	1.47	1.37	1.38	1.36	0.37	0.18	0.07	0.31
Palmitic, (16:0)	25.16	24.32	24.57	23.36	0.41	0.03	0.01	0.66
Palmitoleic, (16:1)	2.23	2.30	2.24	2.25	0.10	0.95	0.99	0.75
Stearic, (18:0)	13.55	12.44	12.64	12.00	0.54	0.24	0.07	0.66
Oleic, (18:1)	38.86	40.15	39.62	39.68	0.46	0.25	0.35	0.19
Vaccenic, (18:1)	4.20	4.29	4.24	4.20	0.11	0.92	0.91	0.55
Linolenic, (18:2)	10.03	10.69	10.93	12.49	0.47	0.01	0.01	0.34
α-linolenic, (18:3)	0.40	0.39	0.37	0.40	0.01	0.68	0.99	0.31
Others	4.07	4.00	3.97	4.21	0.18	0.81	0.64	0.42
Total saturated fatty acids	40.18	38.13	38.60	36.7	40.88	0.06	0.01	0.91
Total mono-unsaturated fatty acids	45.30	46.76	46.10	46.13	0.60	0.41	0.49	0.24
Total poly-unsaturated fatty acids	10.43	11.09	11.30	12.90	0.49	0.01	0.01	0.34

[a]DDGS = Corn distillers dried grain with solubles.
[b]SEM = Standard error of the mean.

Table 5. Response and effect of dietary [a]DDGS inclusion on sensory characteristics of longissumus muscle of growing-finishing pigs.

Item	DDGS[a], %				SEM[b]	*P*-value		
	0	5	10	15		Treatment	Linear	Quadratic
Attribute[c], mm								
General appearance	97.35	88.97	88.03	94.85	5.34	0.58	0.69	0.18
Toughness	71.97	65.95	67.19	79.50	5.61	0.33	0.36	0.11
Chewiness	79.74	75.60	76.78	81.18	5.51	0.87	0.88	0.43
Juiciness	73.23	78.90	82.05	75.73	4.88	0.60	0.62	0.22
Pork flavor	83.00	82.95	80.11	79.86	4.57	0.93	0.54	0.98
Off-flavor	43.13	43.79	43.85	58.62	5.87	0.17	0.07	0.22
Aftertaste pork flavor	80.58	81.45	72.90	69.18	4.80	0.19	0.04	0.62
Aftertaste off-flavor	45.53	40.03	40.32	61.86	5.61	0.01	0.05	0.01
Overall acceptability	83.00	75.87	80.51	74.92	5.01	0.54	0.31	0.80

[a]DDGS = Corn distillers dried grain with solubles.
[b]SEM = Standard error of the mean.
[c]Attribute description provided in Table 1.

of DDGS in the diet of finishing pigs resulted in a linear reduction in the concentration of total saturated fatty acids (TSFA; $P = 0.01$). Increasing the concentration of DDGS resulted in increased relative TUFA concentration in backfat samples ($P = 0.01$). Reports in the literature indicate that a reduction in the content of saturated fatty acids in adipose tissue occurs when sources of unsaturated fatty acids are included in the diet of pigs. This alteration in the saturation of backfat observed in the present study may be the consequence of increased concentration of unsaturated fatty acids in the diets as dietary DDGS concentration increased.

The effects of DDGS inclusion on taste characteristics of the longissimus muscle of finishing barrows are provided in Table 5. The inclusion of increasing concentration of DDGS in the diets did not affect general appearance, texture, chewiness, juiciness, pork flavor, off-flavor, aftertaste, and overall acceptability of longissimus muscle ($P > 0.05$). A significant effect of treatment was detected for aftertaste off-flavor ($P = 0.01$). Off flavor was more pronounced as dietary DDGS increased ($P = 0.01$). In general, increasing dietary DDGS had minimal effects on pork sensory characteristics.

Conclusions

These results suggest that the inclusion of increasing levels of DDGS in diets of finishing pigs from the University of Nebraska–Lincoln nutrition line did not affect carcass characteristics; however, as DDGS inclusion increased HCW was reduced.

Dressing percentage, chemical composition, color, and sensory characteristics of the LM was not affected by dietary DDGS up to 15%.

The results of this investigation suggest dietary inclusion of DDGS may result in an increase in total unsaturated fatty acid and a decrease in total saturated fatty acid concentrations.

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