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EFFECTS OF INCREASING DIETARY DRIED DISTILLERS GRAINS WITH SOLUBLES AND GLYCEROL ON PORK LOIN QUALITY^{1,2}

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Summary

A total of 1,160 barrows (PIC, initially 68.4 lb) were used in a 70-d study to determine the influence of dried distillers grains with solubles (DDGS) and glycerol on pork loin quality attributes. The pigs were blocked by weight and randomly assigned to 1 of 6 dietary treatments with 7 replications per treatment. Pigs were fed corn-soybean meal-based diets with the addition of DDGS, glycerol, or a combination of these. The treatments were arranged in a 2 × 3 factorial with main effects of DDGS (0 or 20%) and glycerol (0, 2.5, or 5%). Pork loins from the 2 heaviest barrows from each pen were utilized for analysis. There were no DDGS × glycerol interactions for purge loss, instrumental color ($L^*a^*b^*$), visual color, marbling score, drip loss, visual color, pH, Warner-Bratzler shear force (WBSF), cook loss, and most sensory characteristics. However, there was a DDGS × glycerol interaction ($P < 0.03$) for off-flavor intensity. Specifically, pigs fed 20% DDGS without added glycerol had more off-flavors than pigs fed any other treatment. Pigs fed diets with added DDGS had higher WBSF values, lower myofibrillar tenderness, lower overall tenderness scores, lower connective tissue scores, and more off-flavors ($P < 0.04$)

than pigs fed diets with no DDGS. In conclusion, feeding pigs 20% DDGS resulted in less tender chops with more off-flavors. Yet, the inclusion of glycerol in the diet decreased the intensity of off-flavors in pork chops.

Key words: dried distillers grains with solubles, glycerol, off-flavor, pork quality, tenderness

Introduction

The rapid expansion of the biofuels industry has increased the amount of grain coproducts available for livestock production while simultaneously decreasing the amount of traditional feedstuffs. The increased costs of traditional feedstuffs and limitations on inclusion rates of coproducts due to their unique chemical properties has presented many new challenges to pork producers. For example, dried distillers grains with solubles (DDGS) have an oil content of roughly 10%, which is primarily made up of highly unsaturated fatty acids. Monogastrics, such as swine and poultry, will assimilate subcutaneous, intermuscular, and intramuscular fat with a fatty acid profile similar to their diet. Therefore, feeding highly unsaturated fatty acids may result in softer, less oxidatively stable adipose tissue, which will in

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turn affect consumer acceptability. Additionally, glycerol, a coproduct of biodiesel manufacturing, has potential as a feedstuff in animal diets because of its price and availability.

To date, some limited research has been conducted on growth and performance of pigs fed DDGS and glycerol. Yet, research addressing the effects of DDGS and glycerol on palatability parameters of pork loins is not currently available. Therefore, the objective of this research was to determine the effects of feeding various levels of DDGS and glycerol on economically important quality traits including purge loss, drip loss, color, marbling, Warner-Bratzler shear force (WBSF), pH, and sensory panel scores for tenderness, juiciness, and off-flavor.

Procedures

Procedures used in this experiment were approved by the Kansas State University Institutional Animal Care and Use Committee. The experiment was conducted in southwest Minnesota in a commercial swine facility. The facility had a slatted floor, and each pen was equipped with a 4-hole dry self-feeder and 1 cup waterer. The facility was a double-curtain-sided, deep-pit barn that operated on mechanical ventilation during the summer and automatic ventilation during the winter. Pigs were fed in late summer and fall of 2007.

A total of 1,160 barrows (PIC 337 × 1050, initially 68.4 lb) were used in the 70-d study. The pigs were blocked by weight and randomly assigned to 1 of 6 treatments with 7 replications per treatment. The pigs were fed a corn-soybean meal-based diet in 4 phases (Duttlinger et al., Swine Day 2008 Report of Progress, p. 171). The treatments were arranged in a 2 × 3 factorial with main effects of DDGS (0 or 20%) and glycerol (0, 2.5, or 5%).

On d 70 of the study, the 2 heaviest barrows were visually selected, removed, individually tattooed, and shipped to a commercial

swine harvest facility (JBS Swift & Company processing plant, Worthington, MN) for slaughter. Following slaughter and chilling (24 h), the loins were removed from the left side of the carcass. The loins were then transported and stored at the Kansas State University Meat Laboratory. On the d 10 postmortem, purge loss, drip loss, visual color, marbling score, and instrumental color were measured.

Purge loss was measured by weighing the whole loin in the packaging material, removing the loin, blotting it dry, and reweighing the loin and the dried packaging material. Purge loss was calculated by taking the initial weight minus the packaging weight minus the final weight divided by the initial weight minus the packaging weight. Loins were fabricated into 1-in. chops and allowed to bloom for at least 1 h prior to visual and instrumental color measurements. Color measurements were taken on a cross section of the *longissimus dorsi* muscle located in the center loin region immediately posterior to the end of the *spinalis dorsi* muscle. Instrumental color was measured by using a Hunter Lab Miniscan Colorimeter with A illuminate (Hunter Associated Laboratories Inc., Reston, VA) and is reported as L* (lightness), a* (redness), and b* (yellowness) values. Visual color and marbling were evaluated by using the 1999 National Pork Producers Council's color and marbling standards. Drip loss was measured from a single 1-in. center-cut chop from each loin. Each chop was weighed and placed into a plastic bag immediately following fabrication. This chop was then placed into refrigerated storage (32 to 38°F) for 24 h. Chops were then reweighed to determine the amount of purge loss accumulation for the preceding 24-h period. Drip loss was calculated by taking initial weight minus final weight divided by initial weight.

Five center-cut chops were individually vacuum packaged and frozen (-40°F) for pH, WBSF, cook loss, and sensory characteristics. Chops were removed from the freezer and thawed in a refrigerator (32 to 38°F) over-

night. Chops were removed from the package, pH was measured, and chops were weighed to determine initial weight. The pH was measured by using an Accumet Basic pH Meter (Fisher Scientific, Waltham, MA) and Pinnacle Series Gel Spear Point electrode (Nova Analytics Corporation, Woburn, MA). The chops were cooked to an internal temperature of 104°F, turned, and cooked to a final internal temperature of 158°F in a dual-airflow convection gas oven (Blodgett, model DFC-102 CH3, G.S. Blodgett Co., Burlington, VT). Chops were monitored with copper-constantan thermocouples placed in the approximate geometric center of each chop and attached to a Doric temperature recorder (Model 205; Vas Engineering, San Francisco, CA). Following a 30-min cooling period, chops were reweighed to determine cooking loss percentages. Chops were chilled at 32 to 38°F overnight and six 0.5-in. cores were removed parallel to the muscle fiber direction. Each core was sheared once perpendicular to the direction of the muscle fibers by using the Warner-Bratzler V-shaped blunt blade (G-R Manufacturing Co., Manhattan, KS) attached to an Instron Universal Testing Machine (model 4201, Instron Corp., Canton, MA) with a 50-kg compression load cell and a cross head speed of 250 mm/min. Peak shear force values were recorded.

Sensory chops were removed from the package, cooked to an internal temperature of 104°F, turned, and cooked to a final internal temperature of 158°F in a dual-airflow convection gas oven. Cooked chops were then cut into 1-in. × 0.5-in. × 0.5-in. samples. Samples were kept warm in blue enamel double boiler pans with warm water in the bottom portion. Eight trained panelists were given 2 cubes of each chop to evaluate sensory characteristics. Each panel conducted sensory analysis on a warm-up chop and a chop from each treatment. Sensory characteristics evaluated include myofibrillar tenderness, juiciness, pork flavor intensity, connective tissue, overall tenderness, and off-flavor intensity.

The experimental design was a 2 × 3 factorial. Data were analyzed as a completely randomized design by using the PROC GLM procedure of SAS with pen serving as the experimental unit. Main effects and interactions between pigs fed DDGS and glycerol were tested.

Results and Discussion

The results of instrumental and visual measurements for the effects of DDGS and glycerol treatments are listed in Table 1. There were no DDGS × glycerol interactions ($P > 0.05$) observed for purge loss, instrumental color (L^* , a^* , and b^*), visual color, marbling score, drip loss, pH, WBSF, and cooking loss. Yet, there were main effect differences for L^* and WBSF. The L^* values decreased for pigs fed 2.5% glycerol, which is indicative of a darker color. This effect was not linear in nature because the 5.0% glycerol treatment was not different ($P > 0.05$) from the control treatment. In addition, WBSF values were ($P < 0.04$) higher in loins from pigs fed 20% DDGS regardless of glycerol level, indicating a less tender product.

The results of trained sensory panel measurements for the effects of DDGS and glycerol treatments are listed in Table 2. There were no interactions observed ($P > 0.05$) for DDGS × glycerol treatments for myofibrillar tenderness, juiciness, pork flavor intensity, connective tissue amount, and overall tenderness. In contrast, there was an interaction observed ($P < 0.03$) for DDGS × glycerol treatments for off-flavor intensity. Specifically, the 20% DDGS treatment without glycerol addition had more off-flavor than all other treatments. Off-flavors commonly cited by panelists were sour, metallic, oxidized, stale, and rancid. This indicates that the addition of glycerol at 2.5 and 5.0% in the diet decreases off-flavor scores as a result of 20% DDGS inclusion. The increase in off-flavors is of concern for diets with 20% DDGS inclusion. However, because this was not a consumer study, we cannot extrapolate these results to mean that

consumers will find the product objectionable. Furthermore, the addition of 20% DDGS to the diet increased ($P < 0.03$) myofibrillar toughness, increased ($P < 0.03$) the amount of connective tissue, and decreased ($P < 0.02$) overall tenderness as observed from the greater WBSF values compared with diets containing no DDGS. Tenderness is a very important sensory trait to consumers who purchase meat products. Therefore, any decrease in tenderness as a result of a feeding regime should be further investigated to determine its short- and long-term effects on pork consumption.

In summary, feeding 0 and 20% DDGS in combination with 0, 2.5, and 5% glycerol had

minimal effects on most of the pork loin quality parameters tested in this study. However, feeding pigs 20% DDGS increased WBSF values and lowered overall tenderness scores, indicating that the product was less tender than controls. In addition, feeding 20% DDGS resulted in increased levels of detectable off-flavors in pork loin chops, but off-flavors of these chops were not different from controls when glycerol was added to the diet at 2.5 and 5.0%. This indicates that glycerol may be beneficial when added to the diet to control off-flavor production but will not mitigate the decrease in tenderness observed in this study for chops from pigs fed 20% DDGS.

Table 1. Influence of dried distillers grains with solubles (DDGS) and glycerol on purge loss, instrumental color ($L^*a^*b^*$), visual color, marbling score, drip loss, pH, Warner-Bratzler shear force (WBSF), and cooking loss

Item	0% DDGS			20% DDGS			SE	<i>P</i> -value		
	Glycerol, %			Glycerol, %				D×G	DDGS	Glycerol
	0	2.5	5	0	2.5	5				
Purge loss, %	1.76	1.75	1.45	1.55	1.61	1.69	0.24	0.57	0.84	0.89
Instrumental color										
L^* ¹	61.03	59.96	61.96	61.91	59.95	62.34	0.91	0.87	0.56	0.05
a^* ²	20.51	20.11	20.97	20.16	20.31	20.64	0.41	0.72	0.61	0.29
b^* ³	17.85	17.10	17.94	17.57	17.61	18.07	0.48	0.69	0.75	0.37
Visual color ⁴	3.2	3.5	3.3	3.0	3.4	3.1	0.20	0.96	0.29	0.13
Marbling score ⁵	2.2	1.6	2.0	2.3	2.0	1.8	0.27	0.50	0.82	0.25
Drip loss, %	2.47	2.89	2.35	2.99	3.02	2.95	0.44	0.86	0.26	0.78
pH	5.7	5.7	5.7	5.7	5.7	5.7	0.003	0.95	0.13	0.78
WBSF, lb	7.0	7.2	6.8	7.3	8.7	7.2	0.20	0.27	0.04	0.06
Cooking loss, %	25.55	25.72	25.72	25.82	24.82	27.62	0.85	0.24	0.52	0.23

¹ 0 = black, 100 = white.

² Increasing redness.

³ Increasing yellowness.

⁴ 1 = pale pinkish gray to white, 2 = grayish pink, 3 = reddish pink, 4 = dark reddish pink, 5 = purplish red, 6 = dark purplish red (NPPC, 1999).

⁵ Visual scale, which approximates the percentage of intramuscular fat content (NPPC, 1999).

Table 2. Influence of dried distillers grains with solubles (DDGS) and glycerol on trained sensory panel scores

Item	0% DDGS			20% DDGS			SE	<i>P</i> -value		
	Glycerol, %			Glycerol, %				D×G	DDGS	Glycerol
	0	2.5	5	0	2.5	5				
Myofibrillar tenderness ¹	5.9	5.9	6.0	5.7	5.6	5.7	0.16	0.92	0.03	0.85
Juiciness ²	5.3	5.2	5.2	5.1	5.2	5.2	0.11	0.31	0.21	0.86
Pork flavor intensity ³	5.5	5.5	5.5	5.4	5.4	5.5	0.08	0.57	0.35	0.92
Connective tissue amount ⁴	7.5	7.6	7.6	7.5	7.2	7.4	0.10	0.25	0.03	0.56
Overall tenderness ¹	6.2	6.3	6.3	6.0	6.0	6.0	0.14	0.82	0.02	0.84
Off-flavor intensity ⁴	7.7	7.6	7.7	7.2	7.7	7.5	0.11	0.03	0.04	0.11

¹ Myofibrillar and overall tenderness scale: 1 = extremely tough, 2 = very tough, 3 = moderately tough, 4 = slightly tough, 5 = slightly tender, 6 = moderately tender, 7 = very tender, and 8 = extremely tender.

² Juiciness scale: 1 = extremely dry, 2 = very dry, 3 = moderately dry, 4 = slightly dry, 5 = slightly juicy, 6 = moderately juicy, 7 = very juice, and 8 = extremely juicy.

³ Pork flavor scale: 1 = extremely bland, 2 = very bland, 3 = moderately bland, 4 = slightly bland, 5 = slightly intense, 6 = moderately intense, 7 = very intense, and 8 = extremely intense.

⁴ Connective tissue and off flavor intensity scale: 1 = abundant, 2 = moderately abundant, 3 = slightly abundant, 4 = moderate, 5 = slight, 6 = traces, 7 = practically none, and 8 = none.