The Effect of Corn Distillers Dried Grain with Solubles (DDGS) on Growth Performance of Growing-Finishing Pigs

Growth performance of growing-finishing pigs was reduced as dietary DDGS inclusion increased from 0 to 15%. These results appear to be affected by the fiber content of the DDGS source used in this study.

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Summary

Two-hundred forty growing-finishing pigs were used to evaluate the feeding value of distillers dried grains with solubles (DDGS). Treatments consisted of 0, 5, 10 and 15% dietary DDGS inclusion. Treatments did not affect average daily gain (ADG), average daily feed intake (ADFI) or gain: feed (G:F) during the grower 1 period ($P > 0.05$). During the grower 2 period, ADG and ADFI linearly decreased as DDGS increased ($P < 0.05$). No differences among treatments were detected throughout the feeding phase finisher 1 for ADG, ADFI, and G:F ($P > 0.05$). During the finisher 2 feeding phase, there was a linear reduction in ADG and ADFI in response to dietary DDGS inclusion ($P = 0.01$). Overall, linear reductions in ADG, ADFI, and G:F were recorded as dietary DDGS increased ($P < 0.05$). Backfat and loingissimus muscle area decreased as dietary DDGS concentration increased ($P < 0.05$). Overall, growth performance was reduced as dietary DDGS inclusion increased from 0 to 15%. The reduction in performance may have been partially explained or exacerbated by the elevated fiber concentration detected in the source of DDGS used in this study.

Introduction

The maximum amount of DDGS that can be included in the diet of growing-finishing pigs is debated. Conflicting results can be found in the literature. Some authors recommend dietary DDGS inclusion up to 30%, while others recommend no more than 15%. In general, DDGS contains elevated concentrations of fat, crude protein (CP), and lysine (lys); however, variability exist among DDGS sources. The inclusion of DDGS in diets of finishing pigs may require the addition of crystalline amino acids (AA) in order to maintain the lys to essential AA ratios recommended for maximum growth performance. The following experiment was designed to evaluate DDGS inclusion rates of 0, 5, 10, and 15% in growing-finishing diets formulated on a total lys basis.

Procedures

Animals and facilities

This experimental protocol was reviewed and approved by the Institutional Animal Care and Use of the University of Nebraska–Lincoln. Two hundred forty barrows and gilts [(Danbred × NE white line) × Danbred] were used in a 16-week study. The initial average weight was 49.2 lb. Five barrows and five gilts were housed in each of 24 pens, and there were six replicates for each of the four dietary treatments.

Pigs were housed in a 24-pen building equipped with automatic environmental control. Pens dimensions were 4.95 × 15.84 ft and each pen was equipped with automatic feeder and waterer. The flooring was one-half solid concrete and one-half concrete slats. Pigs had ad libitum access to feed and water throughout the experimental period.

Dietary treatments

Pigs received a four phase dietary growing-finishing regime (Tables 1 and 2). The diets included 0, 5, 10 or 15% DDGS. Crystalline lys was incorporated into diets containing DDGS in order to maintain a constant total lys concentration among diets. Other nutrient concentrations were formulated to meet or exceed allowances identified in the Nebraska–South Dakota Swine Nutrition Guide.

Data and sample collection

Pigs and feeders were weighed at 0800 at the beginning of the experiment and biweekly thereafter. Feed disappearance was estimated by the difference between feed offered and feed remaining on the feeder at the end of each biweekly period. Body weight gain was estimated by the difference between the weight at the beginning and at the end of each biweekly period. Average daily gain (ADG), average daily feed intake (ADFI), and ADG: ADFI (G:F) were estimated based on the individual biweekly body weight gain and feed disappearance. At the beginning of the experiment and every eight weeks thereafter, ultrasound was used to measure backfat thickness (BF) and longissimus muscle area (LMA) at the 10th rib.

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Table 1. Ingredient, calculated and analyzed composition of growing pig diets, as-fed basis.

	Grower 1 (45-80 lb)				Grower 2 (80-130 lb)			
	DDGS[c], %							
Item, %	0	5	10	15	0	5	10	15
Corn	69.39	67.00	64.54	62.05	74.00	71.68	69.42	66.97
Soybean meal, 46.5% CP	25.40	22.80	20.25	17.75	21.70	19.00	16.25	13.70
Tallow	2.50	2.50	2.50	2.50	2.00	2.00	2.00	2.00
Dicalcium phosphate	1.15	1.05	1.00	0.90	0.85	0.75	0.70	0.60
Limestone	0.90	0.95	0.97	1.02	0.82	0.90	0.92	0.97
Salt	0.22	0.20	0.17	0.15	0.22	0.20	0.17	0.15
Vitamin premix[a]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Trace mineral mix[b]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
L-Lysine•HCl	0.13	0.20	0.26	0.32	0.10	0.16	0.23	0.30
DDGS[c]	0.00	5.00	10.00	15.00	0.00	5.00	10.00	15.00
Analyzed Composition								
CP[d], %	17.24	17.10	17.45	17.41	15.82	16.15	16.07	16.10
GE[e], Mcal[f]/lb	1.80	1.83	1.86	1.88	1.80	1.83	1.85	1.88
NDF[f], %	10.77	13.14	17.37	17.11	12.17	14.10	12.59	14.26
EE[g], %	4.87	5.42	5.62	6.00	4.41	4.84	5.26	5.63
Calculated Composition								
Lysine, %	1.00	1.00	1.00	1.00	0.88	0.88	0.88	0.88
CP[d], %	18.00	18.00	18.00	18.00	16.50	16.50	16.50	16.50
ME[e], Mcal[f]/lb	1.55	1.53	1.52	1.51	1.55	1.53	1.52	1.51

[a]Supplied per kilogram of diet at 0.2% inclusion: vitamin A supplied as retinyl acetate, 4,400 IU; cholecalciferol, 440 IU; a-tocopherol acetate, 24 IU; menadione sodium bisulfite, 3.5 mg; riboflavin, 8.8 mg; d-pantothenic acid, 17.6 mg; niacin, 26.4 mg; vitamin B_{12}, 26.4 mg.
[b]Supplied per kilogram of diet at 0.1% of inclusion: Zn (as ZnS_4O), 85 mg; Fe (as $FeSO_4 \cdot H_2O$), 85 mg; Mn (as MnO), 20 mg; Cu (as $CuSO_4 \cdot 5\ H_2O$), 7 mg; I (as $Ca(IO_3) \cdot H_2O$), 0.17 mg; Se (as Na_2SeO_3), 0.17 mg.
[c]DDGS = Corn distillers dried grain with solubles.
[d]CP = Crude protein.
[e]ME = Metabolizable energy.
[f]NDF = Neutral detergent fiber.
[g]EE = Ether extract.

Table 2. Ingredient, calculated and analyzed composition of finishing pig diets, as-fed basis.

	Finisher 1 (130-190 lb)				Finisher 2 (190-250 lb)			
	DDGS[c], %							
Item	0	5	10	15	0	5	10	15
Corn	80.27	77.65	75.31	72.95	85.1	82.6	80.27	77.79
Soybean meal, 46.5% CP	15.60	13.25	10.60	8.00	11.00	8.50	5.85	3.35
Tallow	2.00	2.00	2.00	2.0	2.00	2.00	2.00	2.00
Dicalcium phosphate	0.75	0.67	0.60	0.50	0.60	0.55	0.47	0.40
Limestone	0.80	0.85	0.90	0.95	0.80	0.83	0.87	0.90
Salt	0.22	0.20	0.17	0.15	0.22	0.20	0.18	0.17
Vitamin premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral mix	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
L-Lysine•HCl	0.10	0.12	0.16	0.20	0.02	0.06	0.10	0.13
DDGS[c]	0.00	5.00	10.00	15.00	0.00	5.00	10.00	15.00
Analyzed Composition								
CP[d], %	13.53	13.67	13.93	14.33	12.04	11.94	12.11	12.16
GE[e], Mcal/lb	1.80	1.84	1.86	1.88	1.82	1.84	1.85	1.88
NDF[f], %	8.80	10.24	11.67	14.27	9.59	12.92	13.17	15.35
EE[g], %	4.80	5.34	5.78	6.18	5.12	5.47	5.76	6.13
Calculated Composition								
Lysine, %	0.72	0.72	0.72	0.72	0.55	0.55	0.55	0.55
CP[d], %	14.20	14.20	14.20	14.20	12.30	12.30	12.30	12.30
ME[e], Mcal/lb	1.55	1.54	1.52	1.51	1.55	1.54	1.52	1.51

[a]Supplied per kilogram of diet at 0.15% inclusion: vitamin A supplied as retinyl acetate, 3,300 IU; cholecalciferol, 330 IU; a-tocopherol acetate, 18 IU; menadione sodium bisulfite, 2.64 mg; riboflavin, 6.60 mg; d-pantothenic acid, 13.23 mg; niacin, 19.80 mg; vitamin B_{12}, 19.80 mg.
[b]Supplied per kilogram of diet at 0.1% of inclusion: Zn (as ZnS_4O), 85 mg; Fe (as $FeSO_4 \cdot H_2O$), 85 mg; Mn (as MnO), 20 mg; Cu (as $CuSO_4 \cdot 5\ H_2O$), 7 mg; I (as $Ca(IO_3) \cdot H_2O$), 0.17 mg; Se (as Na_2SeO_3), 0.17 mg.
[c]DDGS = Corn distillers dried grain with solubles.
[d]CP = Crude protein.
[e]ME = Metabolizable energy.
[f]NDF = Neutral detergent fiber.
[g]EE = Ether extract.

Table 3. Response and effect of dietary DDGS[a] inclusion on growth performance of growth finishing pigs.

	DDGS[a], %					*P*-value		
Item	0	5	10	15	SEM[b]	Treatment	Linear	Quadratic
No. of pigs	60	60	60	60				
No. of pens	6	6	6	6				
Initial weight, lb	49.44	49.42	48.85	49.27	0.32	0.57	0.47	0.51
Final weight, lb	260.65	252.96	249.96	240.84	4.56	0.02	0.02	0.54
Grower 1 (week 1 to 4)								
ADG[c], lb	1.66	1.61	1.53	1.56	0.04	0.24	0.08	0.43
ADFI[d], lb	3.49	3.43	3.34	3.43	0.05	0.32	0.30	0.18
G:F[e]	0.47	0.47	0.45	0.45	0.01	0.39	0.10	0.89
Grower 2 (week 5 to 8)								
ADG[c], lb	1.82	1.60	1.72	1.60	0.05	0.02	0.03	0.38
ADFI[d], lb	4.83	4.40	4.58	4.50	0.08	0.01	0.04	0.05
G:F[e]	0.37	0.36	0.37	0.35	0.01	0.25	0.17	0.61
Finisher 1 (week 9 to 12)								
ADG[c], lb	1.93	1.94	1.85	1.80	0.06	0.83	0.11	0.65
ADFI[d], lb	6.29	5.85	5.91	5.84	0.17	0.23	0.11	0.28
G:F[e]	0.30	0.33	0.31	0.30	0.01	0.29	0.77	0.16
Finisher 2 (week 13 to 16)								
ADG[c], lb	2.05	1.92	1.83	1.79	0.67	0.06	0.01	0.51
ADFI[d], lb	7.04	7.09	6.86	6.73	0.17	0.44	0.14	0.60
G:F[e]	0.29	0.27	0.26	0.26	0.01	0.04	0.01	0.13
Overall (week 1 to 16)								
ADG[c], lb	1.86	1.76	1.73	1.68	0.03	0.01	0.01	0.39
ADFI[d], lb	5.40	5.14	5.13	5.11	0.09	0.11	0.04	0.20
G:F[e]	0.34	0.34	0.33	0.33	0.01	0.01	0.01	0.43

[a]DDGS = Corn distillers dried grain with solubles.
[b]SEM=Standard error of the mean.
[c]ADG = Average daily gain.
[d]ADFI = Average daily feed intake.
[e]G:F = Gain to feed ratio.

Table 4. Response and effect of dietary DDGS[a] inclusion on BF[b] and LMA[c] of growing-finishing pigs.

	DDGS[a], %					*P*-value		
Item	0	5	10	15	SEM[d]	Treatment	Linear	Quadratic
No. of pigs	60	60	60	60				
No. of pens	6	6	6	6				
Initial weight , lb	49.44	49.42	48.85	49.27	0.32	0.57	0.47	0.51
Final weight, lb	260.65	252.96	246.96	240.84	4.56	0.02	0.01	0.54
Initial (day 0)								
BF[b], in	0.27	0.29	0.28	0.28	0.01	0.19	0.38	0.21
LMA[c], in^2	1.45	1.48	1.45	1.49	0.12	0.33	0.22	0.84
Day 56								
BF[b], in	0.47	0.44	0.48	0.43	0.01	0.08	0.31	0.43
LMA[c], in^2	3.46	3.29	3.31	3.24	0.07	0.21	0.06	0.52
Final (d 112)								
BF[b], in	0.81	0.76	0.79	0.71	0.03	0.05	0.03	0.52
LMA[c], in^2	5.62	5.53	5.45	5.28	5.16	0.13	0.02	0.93

[a]DDGS=Corn distillers dried grain with solubles.
[b]BF=Back fat at 10th rib.
[c]LMA=Longissimus muscle area at 10th rib.
[d]SEM=Standard error of the mean.

Statistical analysis

The MIXED procedure (SAS Inst. Inc., Cary, N.C.) was used to analyze the data. Contrasts were designed to evaluate linear and quadratic responses to addition of DDGS to dietary treatments. Pen was considered the experimental unit and the model was a completely randomized design. Pen was considered a random effect.

Results and Discussion

The growth performance responses of growing-finishing pigs to varying dietary concentrations of DDGS are provided in Table 3. Final weight decreased linearly as DDGS increased ($P = 0.02$). During the grower 1 period, treatments did not affect ADG, ADFI, or G:F ($P > 0.05$). Treatment did affect ADG during the grower 2 period ($P = 0.02$). A linear ($P = 0.03$) response of ADG to dietary DDGS concentration indicated that ADG decreased as dietary DDGS inclusion increased. Also during grower 2, treatment effected ADFI ($P = 0.01$). We observed a linear reduction in ADFI as dietary DDGS concentration increased ($P = 0.04$). Feed efficiency was not affected by dietary treatment ($P = 0.25$). No differences among treatments were detected throughout the feeding phase finisher 1 for ADG, ADFI, and G:F ($P > 0.05$). During the finisher 2 period, despite the lack of treatment effect ($P = 0.06$), we observed a linear reduction in ADG and G:F in response to dietary DDGS inclusion ($P = 0.01$). For the overall period, ADG and G:F differed among treatments ($P = 0.01$), and a linear reduction in ADG and G:F was recorded as dietary DDGS increased ($P = 0.01$). Although not significant ($P = 0.11$), increased dietary DDGS concentration resulted in a linear reduction in ADFI ($P = 0.04$).

Backfat and LMA results are provided in Table 4. No difference among treatments was detected for BF or LMA at day 0, 56 or 112 ($P > 0.05$); however, at day 112, BF and LMA were reduced as dietary DDGS increased ($P < 0.05$). A number of studies have shown no reduction in growth performance on DDGS inclusion up to 20% of the diet. Our results contradict previous findings.

We initially screened DDGS samples for CP and lysine content. After the completion of the trial, analysis indicated the neutral detergent fiber (NDF) concentrations in the DDGS used were approximately 45 to 50% (See Table 1 for diet com-

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position). Normally, DDGS contains approximately 30 to 40% NDF. The additional concentration of cell wall content found in the DDGS used could explain the reduction in performance associated with increased DDGS inclusion observed in our study. This observation highlights the importance of screening DDGS samples for all nutrient components (including, CP, lysine, fat, and fiber).

Conclusions

Overall, growth performance decreased as dietary DDGS inclusion increased from 0 to 15%. This reduction in performance may have been partially explained or exacerbated by the elevated fiber concentration detected in the source of DDGS used in this study.

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

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