Feeding Value of Diets for Growing-Finishing Pigs with Varying Concentrations of Corn Distillers Dried Grain with Solubles (DDGS)

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Growth performance of growing-finishing pigs was maintained as dietary DDGS inclusion increased from 0 to 15%.

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Summary

Two-hundred and forty pigs (61.73 lb) were used in a 16-week study conducted to evaluate the feeding value of diets with varying concentrations of distillers dried grains with solubles (DDGS) for growing-finishing pigs. Pigs were assigned to one of four dietary treatments. Treatments consisted of a standard diet formulated on a standardized ileal digestible lysine (SID lys) basis in which a portion of dietary corn and soybean meal were replaced to include 0, 5, 10 or 15% of DDGS in a 4-phase feeding regime. Treatment did not affect average daily gain (ADG), average daily feed intake (ADFI) or gain/feed (G:F) during the Grower 1, Grower 2, Finisher 1, and Finisher 2 feeding periods (P > 0.10). Overall, no linear or quadratic effects in ADG and ADFI were recorded as dietary DDGS increased (P > 0.10). At day 21 and 42 backfat (BF) linearly decreased as dietary DDGS concentration increased (P = 0.008 and 0.018, respectively). A linear reduction in longissimus muscle area was recorded on day 42 (P = 0.025). Overall, growth performance was not affected by dietary DDGS inclusion increasing from 0 to 15%. The results of this study suggest that DDGS inclusion up to 15% in diets for growing-finishing pigs formulated on a SID lys basis does not affect optimum growth performance.

Introduction

The inclusion of dietary distillers dried grains with solubles (DDGS) in diets for growing finishing pigs represents a challenge from the diet formulation standpoint mostly due to the variation on nutrient composition among dietary DDGS sources imposed by the process by which starch is extracted. This variation in the composition of the DDGS is responsible in part for the variation in the growth performance of growing-finishing pigs fed diets in which DDGS has been included. Data reported in a previous study *(2008 Nebraska Swine Report)* using the same dietary DDGS inclusion showed that growth performance was linearly decreased as dietary DDGS increased form 0 to 15% . We attributed the inability of DDGS-supplemented diets to maintain maximum growth performance to the increased fiber concentration. In the present study, we screened the DDGS for lysine, crude protein, and fiber concentration in order to formulate the diets with the adequate concentration of nutrients to maximize growth performance. The objective of this study was to evaluate the feeding value of diets with inclusion rates of DDGS of 0, 5, 10 and 15% formulated in a standardized ileal digestible lysine (SID lys) basis for growing-finishing pigs.

Procedures

Animals and Facilities

This experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee of the University of Nebraska–Lincoln. For this 16-week study, 240 barrows and gilts [(Danbred × NE white line) × Danbred] were used. The initial average weight was 61.7 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 half solid concrete and half concrete slats. Pigs had ad libitum access to feed and water throughout the experimental period.

Dietary Treatments

The DDGS used for this experiment was analyzed for total lysine concentration and SID lys was calculated and used to formulate the experimental diets to ensure an adequate lysine supply to maximize growth performance. Pigs were fed diets that included 0, 5, 10 and 15% dietary DDGS formulated in a SID lys basis and arranged in a 4-phase dietary growing-finishing regime (Tables 1 and 2). Crystalline lysine was incorporated into diets containing DDGS

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

	Grower 1 (45 to 80 lb)				Grower 2 (80 to 130 lb)			
	DDGS[a], %							
Item, %	0	5	10	15	0	5	10	15
Corn	71.27	67.36	63.63	60.42	74.47	70.52	66.66	2.37
Soybean meal, 47.5 % CP[d]	23.75	22.75	21.5	19.75	21	20	19	18.25
Tallow	2	2	2	2	2	2	2	2
Dicalcium phosphate	1.2	1.12	1.05	0.95	0.85	0.75	0.65	0.6
Limestone	0.89	0.92	0.97	1.025	0.84	0.9	0.95	0.97
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin premix[b]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Trace mineral mix[c]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine•HCL	0.15	0.15	0.17	0.19	0.15	0.15	0.15	0.15
L-Tryptophan	0.01	0.01	0.01	0.01	0	0	0	0
L-Threonine	0.05	0.02	0.01	0	0.03	0.02	0	0
DL-Methionine	0.02	0	0	0	0	0	0	0
DDGS	0	5	10	15	0	5	10	15
Analyzed composition								
CP[d], %	16.61	17.18	17.521	8.23	15.66	16.36	16.60	17.25
EE[e], %	4.58	4.96	5.37	5.65	4.53	4.91	5.15	5.66
Calculated composition								
SID[f] lysine, %	0.9	0.9	0.9	0.9	0.83	0.83	0.83	0.83
CP[d], %	17.1	17.6	18	18.2	16.1	16.6	17	17.6
ME[g], kcal[h]/lb	1,543	1,530	1,517	1,505	1,550	1,537	1,525	1,512

[a]DDGS = Corn distillers dried grain with solubles
[b]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
[c]Supplied per kilogram of diet at 0.15% of inclusion: Zn (as ZnS_4O), 128 mg; Fe (as $FeSO_4 \cdot H_2O$), 128 mg; Mn (as MnO), 30 mg; Cu (as $CuSO_4 \cdot 5\ H_2O$), 10.5 mg; I (as $Ca(IO_3) \cdot H_2O$), 0.26 mg; Se (as Na_2SeO_3), 0.26 mg
[d]CP = Crude protein
[e]EE = Ether extract
[f]SID = Standardized ileal digestible
[g]ME = Metabolizable energy
[h]Kcal = Kilocalories (1,000 cal)

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

	Finisher 1 (130 to 190 lb)				Finisher 2 (190 to 250 lb)			
	DDGS[a], %							
Item	0	5	10	15	0	5	10	15
Corn	80.18	76.03	71.83	67.85	86.58	82.3	78.56	74.25
Soybean meal, 47.5 % CP[d]	15.5	14.75	14	139.25	8.6	7.4	6.75	
Tallow	2	2	2	2	2	2	2	2
Dicalcium phosphate	0.7	0.65	0.56	0.47	0.6	0.5	0.42	0.35
Limestone	0.84	0.87	0.9	0.97	0.82	0.87	0.91	0.95
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin premix[b]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral mix[c]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
L-Lysine•HCL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-Tryptophan	0	0	0	0	0.01	0	0	0
L-Threonine	0.07	0	0	0	0.04	0.02	0	0
DL-Methionine	0	0	0	0	0	0	0	0
DDGS[a]	0	5	10	15	0	5	10	15
Analyzed Composition								
CP[d], %	13.00	14.01	14.42	15.14	10.83	11.67	12.32	13.06
EE[e], %	4.39	4.76	4.83	5.35	4.45	4.89	5.32	5.89
Calculated Composition								
SID[f] lysine, %	0.7	0.7	0.7	0.7	0.54	0.54	0.54	0.54
CP, %	14	14.6	15.2	16.3	11.6	12.2	12.4	13.3
ME[g], kcal[h]/lb	1,554	1,542	1,530	1,516	1,557	1,545	1,533	1,520

[a]DDGS = Corn distillers dried grain with solubles
[b]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
[c]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
[d]CP = Crude protein
[e]EE = Ether extract
[f]SID = Standardized ileal digestible
[g]ME = Metabolizable energy
[h]Kcal = Kilocalories (1,000 cal)

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

Item	DDGS[a], %				SEM[b]	*P*-value		
	0	5	10	15		Treatment	Linear	Quadratic
No. of pigs	60	60	60	60				
Grower 1 (day 0 to 21)								
BW[c] (day 0), lb	61.58	61.54	61.83	61.99	0.320	0.727	0.300	0.755
BF[d] (day 0), in	0.26	0.24	0.25	0.25	0.005	0.195	0.166	0.209
LMA[e] (day 0), in^2	1.65	1.66	1.64	1.62	0.028	0.793	0.368	0.676
ADG[f], lb	1.69	1.69	1.69	1.71	0.093	0.736	0.876	0.495
ADFI[g], lb	3.46	3.37	3.38	3.39	0.057	0.690	0.448	0.395
G:F[h], lb/lb	0.49	0.50	0.46	0.50	0.024	0.657	0.931	0.595
BW (day 21), lb	97.06	98.53	97.45	97.82	2.079	0.974	0.915	0.792
BF (day 21), in	0.38	0.37	0.34	0.35	0.011	0.030	0.008	0.352
LMA (day 21), in^2	2.79	2.84	2.71	2.66	0.046	0.060	0.025	0.283
Grower 2 (day 21 to 42)								
ADG, lb	1.79	1.66	1.80	1.73	0.108	0.791	0.901	0.768
ADFI, lb	4.36	4.29	4.26	4.39	0.170	0.931	0.932	0.533
G:F, lb/lb	0.41	0.39	0.43	0.39	0.017	0.395	0.868	0.680
BW (day 42), lb	134.77	133.42	132.53	134.60	2.291	0.965	0.996	0.674
BF (day 42), in	0.38	0.34	0.36	0.34	0.009	0.032	0.018	0.412
LMA (day 42), in^2	3.57	4.46	3.52	3.50	0.060	0.156	0.205	0.258
Finisher 1 (day 43 to 70)								
ADG, lb	1.85	1.96	1.88	1.94	0.077	0.735	0.555	0.774
ADFI, lb	5.83	5.69	5.81	5.85	0.201	0.948	0.851	0.676
G:F, lb/lb	0.32	0.35	0.33	0.33	0.009	0.192	0.524	0.278
BW (day 70), lb	190.66	191.08	189.42	188.97	3.369	0.830	0.659	0.897
BF (day 70), in	0.55	0.50	0.50	0.50	0.020	0.188	0113	0.159
LMA (day 0), in^2	4.63	4.77	4.67	4.42	0.089	0.064	0.076	0.037
Finisher 2 (day 71 to 112)								
ADG, lb	1.79	1.67	1.71	1.76	0.064	0.545	0.892	0.191
ADFI, lb	6.74	6.32	6.45	6.51	0.183	0.450	0.502	0.203
G:F, lb/lb	0.27	0.26	0.27	0.27	0.007	0.921	0.748	0.546
BW (day 112), lb	268.02	262.90	263.70	262.90	4.536	0.830	0.481	0.639
BF (day 112), in	0.81	0.81	0.73	0.75	0.046	0.469	0.201	0.843
LMA (day 112), in^2	7.06	6.60	6.61	6.59	0.136	0.998	0.989	0.878
Overall (day 0 to 112)								
ADG, lb	1.78	1.76	1.74	1.79	0.053	0.888	0.994	0.467
ADFI, lb	5.39	5.25	5.24	5.36	0.123	0.791	0.840	0.332
G:F, lb/lb	0.33	0.33	0.33	0.33	0.004	0.892	0.688	0.910
Carcass characteristics								
Hot carcass weight, lb	208.38	207.56	204.92	203.46	4.01	0.807	0.344	0.938
DP[i], %	74.20	74.90	73.80	74.40	0.04	0.316	0.751	0.867

[a]DDGS = Corn distillers dried grain with solubles
[b]SEM= Standard error of the mean
[c]BW = Body weight
[d]BF = Backfat
[e]LMA = Longissimus muscle area
[f]ADG = Average daily gain
[g]ADFI = Average daily feed intake
[h]G:F = Gain to feed ratio
[i]DP = Dressing percentage. DP = (live weight/hot carcass weight) × 100

in order to maintain a constant SID lys concentration among diets within feeding phases. 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 the beginning of the experiment and at the end of each dietary phase. Feed disappearance was estimated by the difference between feed offered and feed remaining in the feeder at the end of each feeding phase. Body weight gain was estimated by the difference between the weight at the beginning and at the end of each feeding phase. Average daily gain (ADG), average daily feed intake (ADFI) and ADG:ADFI (G:F) were estimated based on the individual body weight gain at the end of each feeding phase and feed disappearance. At the beginning of the experiment and at the end of each feeding phase, ultrasound was used to measure backfat thickness (BF) and longissimus muscle area (LMA) at the 10th-rib area. At the end of the feeding phase pigs were transported to a commercial facility and harvested.

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Live weight and hot carcass weight (HCW) were recorded and dressing percentage was calculated [DP; DP = (live weight/HCW) × 100].

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. During the Grower period (day 0 to 21), treatments did not affect ADG, ADFI, or G:F ($P > 0.05$); similarly, no linear or quadratic responses to dietary DDGS inclusion were detected by the examination of contrasts ($P > 0.05$). There was a linear reduction on BF in response to dietary DDGS inclusion ($P = 0.008$), with the greatest BF (0.38 in) recorded for pigs fed diets with 0% dietary DDGS inclusion while the lowest BF (0.34 in) was recorded by the pigs fed 10% dietary DDGS inclusion. Although there was only a trend for a treatment effect on LMA ($P = 0.06$) the examination of the data indicated a linear reduction in LMA ($P = 0.025$) in response to dietary DDGS inclusion. The data showed that the smallest LMA (2.66 in^2) was for pigs fed diets with 15% DDGS inclusion, while the greatest LMA was for pigs fed diets with 0% DDGS inclusion (2.79 in^2).

Treatment did not affect ADG, ADFI, G:F, BW or LMA during the Grower 2 period ($P > 0.10$). A linear ($P = 0.018$) response of BF to dietary DDGS concentration indicated that BF decreased as dietary DDGS inclusion increased. The least BF (0.34 in) was for pigs fed 15% dietary DDGS and the greatest corresponded to pigs fed 0% dietary DDGS (0.38 in).

During the Finisher 1 period (day 43 to 70) no differences in ADG, ADFI, G:F, BW or BF were recorded ($P > 0.10$). There was a trend of LMA to decrease linearly in response to increased dietary DDGS concentration ($P = 0.076$).

During the Finisher 2 phase (day 71 to 112) there were no difference in ADG, ADFI, G:F, BF or LMA among treatments ($P > 0.10$). During this feeding phase the greatest ADG (1.79 lb) and ADFI (6.74 lb) was exhibited by the treatment formulated to have 0% dietary DDGS concentration. We showed no effect of treatment on BF and LMA at the end of the Finisher 2 feeding phase ($P = 0.469$ and 0.998 respectively); however, numerically the least BF (0.73 in) corresponded to pigs fed 10% dietary DDGS. Also LMA (7.06 in^2) was numerically the greatest for pigs fed 0% dietary DDGS inclusion. The final BW (day 112) data indicate no difference among treatments ($P = 0.830$).

For the overall period (day 0 to 112), our data indicate there was no difference among treatments on ADG, ADFI and G:F ($P = 0.888$, 0.791, and 0.892, respectively). There was no difference among treatments for HCW or DP ($P = 0.807$ and 0.316 respectively).

These data are in contrast to the results of our previous study *(2008 Nebraska Swine Report)* in which we found that increasing dietary concentration of DDGS from 0 to 15% resulted in a linear reduction in growth performance examined by ADG, ADFI and G:F. The reduced growth performance was partially attributed to increased concentration of neutral detergent fiber (NDF) in the experimental diets associated with the inclusion of DDGS. The results of the present experiment support the findings reported in the literature that indicate that DDGS may be included in diets of growing-finishing pigs up to 20% without negatively affect growth performance. The results of our experiment support the importance of screening DDGS samples for nutrient components especially CP, lysine, fat, and fiber.

Conclusions

Overall, growth performance of growing finishing pigs was maintained as dietary DDGS inclusion increased from 0 to 15%. This result may indicate that DDGS can provide lysine and other nutrients in adequate concentrations to maximize growth performance in growing-finishing pigs from the University of Nebraska herd.

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