Effects of Distillers Dried Grains with Solubles (DDGS) and paylean" Supplementation on Growth Performance of Growing-finishing Pigs

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Growth performance of growing-finishing pigs was not affected by increasing dietary DDGS (0 to 40%) or supplementing ractopamine.

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Summary and Implications

Forty pigs were used in a 14-week, 4-phase regime study conducted to evaluate the feeding value of diets with varying concentrations of DDGS for growing-finishing pig formulated on a standardized ileal digestibility (SID) lysine (lys) basis, DDGS withdrawal at the last feeding phase, and ractopamine (RAC)supplementation four weeks prior harvesting. Treatments consisted in 0, 15 or 40% dietary DDGS inclusion supplemented or not with RAC (4.5 ppm) four weeks prior harvesting. Increased dietary DDGS inclusion resulted in a linear reduction in average daily gain (ADG) during the Grower 1 period (P = 0.002). There were no treatment effects (P > 0.05) of increasing dietary DDGS inclusion for any of the variables examined during the Grower 2 feeding period. No differences among treatments were detected throughout the feeding phase Finisher 1 for ADG, average daily feed intake (ADFI), longissimus muscle area (LMA) and gain:feed (G:F) (P > 0.05). During the Finisher 2 feeding phase, there were no differences among treatments due to dietary DDGS inclusion on any of the variables studied. The inclusion of RAC four weeks prior harvesting did not affect growth performance (ADG, ADFI, and G:F; P = 0.436, 0.217, 0.880 respectively); however, there was a numerical increase in ADG due to RAC inclusion. The examination of 98-day BF and LMA data did not show differences due to RAC inclusion (P = 0.319 and 0.728 respectively). There were no changes in growth performance or ultrasound measurements due to withdrawal of DDGS (P > 0.05). Overall, growth performance was maintained as dietary DDGS inclusion increased from 0 to 40%.

Introduction

Despite the great quantity of information available in reference to nutrient composition and nutrient availability from DDGS, there is no consensus on the dietary inclusion that will maximize growth performance. Evidence available in the literature indicates that dietary inclusion levels up to 30% have been used in diets for growing-finishing without negatively affecting growth performance; however, the maximum amount of DDGS that can be included in the diet of growing-finishing pigs is still unclear.

The concentration of crude protein (CP) and lysine (lys) in DDGS is greater than that of corn; however, variability among sources has been reported. The inclusion of the beta-agonist ractopamine (RAC; Paylean®), has been shown to improve growth performance of finishing pigs when fed four weeks prior to harvesting. Additionally, RAC inclusion has resulted in increased average daily gain (ADG) and gain:feed (G:F), decreased carcass fatness, and increased carcass protein concentration; however, in order to produce these changes in growth performance and composition pigs fed RAC-supplemented diets require greater concentration of dietary AA (specially lys). The increased concentration of AA in DDGS makes it a viable option to use in conjunction with RAC supplementation. In addition, because dietary supplementation of DDGS has been associated with increased unsaturated fat content, dietary RAC addition, DDGS withdrawal during late finishing, or both may alleviate the problems with increased unsaturated fat content associated with DDGS feeding. Therefore, this study was conducted to examine the feeding value of diets with dietary DDGS concentrations of 15 and 40% formulated on a standardized ileal digestible (SID) lys basis and its interaction with the inclusion of RAC, DDGS withdrawal, or both during the last 4 weeks of the finishing period.

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. Forty barrows [(Danbred × NE white line) × Danbred] were used for this 14-week study. The initial average weight was 66.6 lb and the average final weight was 273.2 lb. Pigs were individually penned in fully-slotted pens equipped with automatic feeder and waterers to provide unlimited access to feed and water throughout the duration of the experimental period. Pigs were housed in a building equipped with automatic environmental control located in the UNL Swine Research Unit in Mead, Neb.

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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)			Finisher 1 (130 to 190 lb)		
	DDGS[c], %								
	0	15	40	0	15	40	0	15	40
Treatment	T1	T2	T3 and T4	T1	T2	T3 and T4	T1	T2	T3 and T4
Item, %									
Corn	71.25	60.42	46.06	74.47	62.37	47.05	80.18	67.85	49.9
Soybean meal, 47.5% CP	23.75	19.75	9	21	18.25	8.5	15.5	13	6
Tallow	2	2	2	2	2	2	2	2	2
Dicalcium phosphate	1.2	0.95	0.6	0.85	0.6	0.25	0.7	0.47	0.1
Limestone	0.89	1.02	1.27	0.84	0.97	1.22	0.84	0.97	1.2
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin premix[a]	0.2	0.2	0.2	0.2	0.2	0.2	0.15	0.15	0.15
Trace mineral mix[b]	0.15	0.15	0.15	0.15	0.15	0.15	0.1	0.1	0.1
L-lysine•HCl	0.15	0.19	0.4	0.15	0.15	0.32	0.15	0.15	0.25
L-tryptophan	0.01	0.01	0.01	0	0	0	0	0	0
L-threonine	0.05	0	0	0.03	0	0	0.07	0	0
DL-methionine	0.02	0	0	0	0	0	0	0	0
DDGS[c]	0	15	40	0	15	40	0	15	40
Analyzed Composition									
CP[d], %	16.65	17.90	19.32	15.78	17.52	18.69	13.69	15.44	17.77
EE[e], %	4.78	5.80	7.70	4.83	5.87	7.99	5.10	5.92	7.92
Calculated Composition									
SID[f] Lysine, %	0.9	0.9	0.9	0.83	0.83	0.83	0.7	0.7	0.7
CP[d], %	17.1	18.2	18.6	16.1	17.6	18.3	14	15.6	17.3
ME[g], kcal[h]/lb	1,543	1,505	1,437	1,550	1,512	1,444	1,554	1,516	1,450

[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. 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 0.15% 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. 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]EE = Ether extract
[f]SID = Standardized ileal digestiblility
[g]ME = Metabolizable energy
[h]Kcal = Kilocalories (1,000 cal)

Dietary Treatments

The DDGS used for this experiment was analyzed for total lys concentration and this value was used to formulate diets and ensure an adequate lys supply to maximize growth performance. Diets were formulated on a SID basis arranged in a 4-phase dietary growing-finishing regime (Tables 1 and 2). Four dietary regimens were designed to provide DDGS inclusion of 0, 15 or 40% throughout the experiment or 40% dietary DDGS inclusion during the first three feeding phases and 0% dietary DDGS inclusion during the last feeding phase. Eight treatments were produced by randomly assigning pigs to 1 of 4 dietary treatments or their RAC- supplemented counterparts (4.5 ppm). Crystalline lys was incorporated in order to maintain a constant SID 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 and ultrasound was used to measure backfat thickness (BF) and longissimus muscle area (LMA) at the 10th rib at the beginning and at the end of each of four feeding phases. 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 individual body weight gain and feed disappearance during each feeding phase.

Statistical Analysis

Pen was considered a random effect and each pig was considered an experimental unit. Data were analyzed as a completely randomized design using repeated measures in time by the MIXED procedure (SAS Inst. Inc. Cary, N.C.). Contrasts were designed to evaluate linear and quadratic responses to dietary DDGS inclusion for the four feeding phases and overall. For the analysis of the data generated during the last feeding phase of the experimental period, contrasts were used to examine the effect of DDGS withdrawal and RAC inclusion.

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

	Finisher 2 (130 to 190 lb)							
	DDGS[c], %							
	0	15	40	0	0	15	40	0
Item	T1	T2	T3	T4	T5	T6	T7	T8
Corn	86.56	74.97	55.1	86.56	72.23	62.36	45.98	72.23
Soybean meal, 47.5% CP	9.25	6	1	9.25	23.23	18.2	9.72	3.23
Tallow	2	2	2	2	2	2	2	2
Dicalcium phosphate	0.6	0.35	0	0.6	0.55	0.3	0	0.55
Limestone	0.82	0.95	1.15	0.82	0.61	0.77	0.97	0.61
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin premix[a]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral mix[b]	0.1	0.1	0.1	0.1	0.1	0.1	0.01	0.1
L-Lysine•HCl	0.15	0.17	0.2	0.15	0.46	0.54	0.67	0.46
L-tryptophan	0.01	0	0	0.01	0.04	0.04	0.04	0.04
L-threonine	0.05	0	0	0.05	0.15	0.11	0.05	0.15
DL-methionine	0	0	0	0	0.15	0.09	0	0.15
DDGS[c]	0	15	40	0	0	15	40	0
Paylean® (Ractopamine•HCL)	0	0	0	0	0.02	0.02	0.02	0.02
Analyzed Composition								
CP[d], %	10.79	12.80	16.01	10.84	17.20	18.20	20.03	17.50
EE[e], %	4.73	6.25	7.95	4.95	4.73	5.69	7.86	4.87
Calculated Composition								
SID[f] Lysine, %	0.54	0.54	0.54	0.54	1.13	1.13	1.13	1.13
CP[d], %	11.6	13	15.4	11.6	18.2	18.6	19.1	18.2
ME[g], kcal[h]/lb	1,557	1,519	1,454	1,557	1,505	1,437	1,446	1,505

[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]EE = Ether extract
[f]SID = Standardized ileal digestiblility
[g]ME = Metabolizable energy
[h]Kcal = Kilocalories (1,000 cal)

Results and Discussion

The growth performance responses of growing-finishing pigs to varying dietary concentrations of DDGS, RAC inclusion and dietary DDGS withdrawal are provided in Table 3. During the Grower 1 feeding period (day 0 to 14), increasing dietary DDGS concentration resulted in a linear decrease in ADG ($P = 0.002$); however, DDGS concentration did not affect ADFI, G:F, BF and LMA ($P = 0.613$, 0.128, 0.408, and 0.855, respectively).

For the Grower 2 period (day 14 to 35), there was no difference among treatments for ADG, ADFI, and G:F ($P > 0.05$). In general, pigs fed 40% DDGS during Grower 1 exhibited decreased ADG compared to pigs fed the control diet; however, during Grower 2 that pattern was reversed. No differences in BF or LMA were recorded among treatments at the end of Grower 2 (day 34; $P = 0.674$ and 0.565 respectively).

For the Finisher 1 feeding period (day 35 to 56), treatments did not affect ADG, ADFI, or G:F ($P = 0.745$, 0.713, and 0.290, respectively). The inclusion of dietary DDGS did not affect LMA at the end of the Finisher 1 phase ($P = 0.349$). Unlike previous phases, there was a linear reduction in BF in response to dietary DDGS inclusion ($P = 0.048$). The lowest BF was recorded for 40% DDGS (0.61 in) and the greatest was recorded by 0% DDGS (0.79 in).

During Finisher 2 feeding phase (day 56 to 98), there was no effect of DDGS inclusion on ADG. Average daily gain, ADFI, and G:F were not affected by DDGS withdrawal during the last feeding period ($P = 0.187$, 0.274, and 0.312, respectively). At day 98, BF and LMA were not affected by treatment ($P = 0.804$ and 0.586 respectively). Final body weight was not affected by dietary treatment (DDGS, RAC or DDGS withdrawal; $P = 0.75$).

Overall, for ADG, ADFI and G:F there were no effects of dietary DDGS concentration observed ($P > 0.05$). Numeric trends show a slight increase in ADG in response to RAC. The greatest ADG overall (2.29 lb) was observed for the 15% dietary DDGS supplemented with 4.5 ppm of RAC for four weeks prior harvesting; furthermore, pigs receiving this dietary treatment also exhibited the greatest G:F (0.36 lb/lb).

Our results are consistent with previous findings reported in the literature that reported no changes in growth performance with up to 15% dietary inclusion of DDGS. We showed that it is possible to feed up to 40% dietary DDGS inclusion throughout the growing-finishing period and

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Table 3. **Response and effect of distillers dried grains with solubles (DDGS) inclusion and ractopamine (RAC) on average daily gain (ADG), average daily feed intake (ADFI), gain to feed ratio (G:F), body weight (BW), and longissimus muscle area (LMA) of growing-finishing pigs.**

Treatment	1	5	2	6	3	7	4	8						
DDGS, % for G1, G2, and F1[a]	0	0	15	15	40	40	40	40						
DDGS, % for F2[b]	0	0	15	15	40	40	0	0						
RAC, ppm	0	4.5	0	4.5	0	4.5	0	4.5						
										P-value				
Item									SEM[c]	TRT[d]	L[e]	Q[f]	RAC	W[g]
No. of pigs	5	5	5	5	5	5	5	5						
Grower 1 (day 0 to 14)														
BW (day 0), lb	67.61	65.22	70.12	64.65	67.52	64.65	66.28	66.90	1.629	0.378	0.977	0.535		
LMA (day 0), in^2	1.68	1.64	1.77	1.66	1.72	1.71	1.86	1.67	0.092	0.744	0.341	0.737		
BF (day 0), in	0.36	0.40	0.39	0.33	0.38	0.35	0.37	0.36	0.028	0.618	0.333	0.692		
ADG, lb	2.09	2.01	2.07	2.18	1.74	1.76	1.96	1.92	0.082	0.007	0.002	0.053		
ADFI, lb	4.17	4.01	4.32	4.08	4.39	3.64	4.23	4.06	0.260	0.613	0.878	0.622		
G:F, lb/lb	0.50	0.50	0.48	0.53	0.42	0.48	0.47	0.47	0.024	0.128	0.040	0.416		
BW (day 14), lb	97.20	93.49	99.23	95.21	92.04	90.67	100.37	93.89	2.115	0.297	0.075	0.116		
BF (day 14), in	0.42	0.44	0.41	0.35	0.33	0.40	0.39	0.35	0.035	0.408	0.046	0.427		
LMA (day 14), in^2	2.23	2.15	2.29	2.21	2.19	2.12	2.24	2.13	0.111	0.855	0.746	0.434		
Grower 2 (day 14 to 35)														
ADG, lb	2.27	2.21	2.15	2.36	2.18	2.32	2.32	2.40	0.139	0.465	0.504	0.916		
ADFI, lb	5.71	5.67	5.60	5.78	5.38	5.58	5.76	6.24	0.240	0.672	0.817	0.956		
G:F, lb/lb	0.40	0.39	0.38	0.41	0.40	0.42	0.40	0.39	0.015	0.497	0.370	0.940		
BW (day 35), lb	144.87	139.89	144.34	144.82	144.52	138.58	142.53	144.74	3.766	0.512	0.598	0.401		
BF (day 35), in	0.56	0.55	0.59	0.53	0.49	0.57	0.54	0.57	0.048	0.674	0.705	0.838		
LMA (day 35), in^2	3.55	3.52	4.07	3.65	3.34	3.46	3.79	3.49	0 223	0.565	0.833	0.060		
Finisher 1 (day 35 to 56)														
ADG, lb	2.03	2.18	2.32	2.36	2.09	2.29	2.18	1.90	0.192	0.745	0.859	0.154		
ADFI, lb	6.15	6.50	6.57	7.01	6.37	7.01	6.77	6.79	0.404	0.713	0.524	0.274		
G:F, lb/lb	0.33	0.33	0.35	0.34	0.33	0.36	0.32	0.27	0.015	0.290	0.305	0.336		
BW (day 56), lb	187.69	185.75	193.07	194.70	182.09	187.73	188.53	184.60	6.593	0.750	0.672	0.163		
BF (day 56), in	0.74	0.79	0.66	0.72	0.61	0.71	0.62	0.69	0.062	0.680	0.048	0.510		
LMA (day 56), in^2	4.82	4.76	5.08	5.23	4.34	4.79	5.41	4.43	0.314	0.349	0.699	0.215		
Finisher 2 (day 56 to 98)														
ADG, lb	1.85	1.89	2.12	2.26	1.98	1.87	2.00	2.25	0.146	0.702	0.336	0.065	0.436	0.187
ADFI, lb	6.24	6.46	6.73	6.97	6.64	6.57	6.59	7.36	0.326	0.411	0.248	0.161	0.217	0.274
G:F, lb/lb	0.29	0.29	0.31	0.32	0.30	0.28	0.30	0.30	0.013	0.453	0.176	0.017	0.880	0.312
BW (day 98), lb	265.39	265.31	282.02	289.83	265.44	266.19	272.49	279.20	11.365	0.734	0.822	0.035	0.640	0.384
BF (day 98), in	0.92	0.93	0.96	0.87	0.98	0.82	0.86	0.87	0.082	0.905	0.804	0.956	0.319	0.670
LMA (day 98), in^2	6.45	6.35	6.80	6.82	5.62	6.50	6.79	6.48	0.499	0.468	0.586	0.235	0.728	0.257
Overall (day 0 to 98)														
ADG, lb	2.07	2.07	2.16	2.29	2.01	2.03	2.12	2.12	0.106	0.678	0.159	0.174		
ADFI, lb	5.58	5.67	5.80	5.98	5.56	5.91	5.84	6.11	0.187	0.345	0.386	0.192		
G:F, lb/lb	0.34	0.34	0.35	20.36	0.33	0.34	0.34	0.33	0.011	0.637	0.134	0.162		
Carcass characteristics														
Hot carcass weight, lb	202.28	216.60	197.94	207.32	200.84	225.90	201.24	212.24	10.75	60.523	0.980	0.033	0.564	0.297
DP[h], %	74.15	73.51	74.66	73.74	72.88	73.94	74.08	73.81	0.006	0.485	0.608	0.320	0.610	0.312

[a]G1 = Grower 1; G2 = Grower 2; F1 = Finisher 1
[b]F2 = Finisher 2
[c]SEM = Standard error of the mean
[d]TRT = Treatment
[e]L = Linear
[f]Q = Quadratic
[g]W = Withdrawal
[h]DP = Dressing percentage. DP = (live weight/hot carcass weight) × 100

maintain growth performance. Unexpectedly, we did not detect an effect of RAC on growth performance. The data from this experiment do not support the concept that the withdrawal of DDGS at the end of the growing-finishing period results in improved growth performance. Additional work is underway to determine the effects of DDGS supplementation, withdrawal, and RAC on carcass and meat quality.

Conclusions

Results of this experiment suggest that growth performance of barrows from the University of Nebraska–Lincoln herd was maintained as dietary DDGS inclusion increased from 0 to 40%. The withdrawal of DDGS during the last feeding phase or RAC supplementation did not result in altered growth performance.

[1]Roman Moreno is a research technologist and graduate student; Phillip S. Miller is a professor; and Thomas E. Burkey is an assistant professor in the Animal Science Department; Matthew W. Anderson is the manager; and Jeffrey M. Perkins, Thomas E. McGargill, and Donald R. McClure are research technicians at the UNL Swine Research Farm.