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Effects of Distillers Dried Grains with Solubles Sources and Soybean Meal Level on Growth Performance of Late Nursery Pigs

Abstract

Two experiments were conducted to determine the effects of distillers dried grains with solubles (DDGS) source and soybean meal (SBM) level on growth performance of late nursery pigs. A total of 1,064 and 1,011 pigs (PIC 280 × 1050), initially 23.1 and 24.1 lb body weight (BW), were used in Exp. 1 and 2, respectively, with 21 to 27 pigs per pen. For approximately 21 days after weaning, pigs were fed common phase 1 and 2 diets. Then, pens were assigned to treatments in a randomized complete block design. There were 6 treatments in each experiment with 7 pens per treatment. Treatments 1 to 5 were replicated in Exp. 1 and 2, whereas treatment 6 was fed only in Exp. 1 and treatment 7 was fed only in Exp. 2. Treatments 1 to 3 consisted of diets with 23% conventional DDGS (Valero, Aurora, SD) and 21, 27, or 35% SBM. Treatments 4 and 5 were corn-SBM-based diets with 27 or 35% SBM. Treatment 6 consisted of a corn-SBM-based diet with 20% high protein DDGS (HP DDGS; Purestream 40, Lincolnway Energy, LLC, Nevada, IA) replacing the 23% conventional DDGS with the same amount of SBM (21%) as treatment 1 and same neutral detergent fiber (NDF) as treatment 2. Finally, treatment 7 consisted of a diet similar to treatment 2 but with 23% Lincolnway DDGS (Lincolnway Energy, LLC, Nevada, IA) replacing the 23% conventional DDGS. Data were analyzed with the GLIMMIX procedure of SAS. There was no evidence for treatment × experiment interactions, thus data from treatments 1 to 5 were combined. In Exp. 1, pigs fed diets containing HP DDGS had decreased ($P < 0.01$) average daily gain (ADG) and poorer ($P < 0.01$) feed-to-gain ratio (F/G) compared to pigs fed diets with conventional DDGS at the same NDF level, conventional DDGS at the same SBM level, or corn-SBM diet. In Exp. 2, there was no evidence for differences ($P > 0.10$) in performance of pigs fed diets with Lincolnway DDGS or conventional DDGS. Feeding diets with 23% conventional DDGS decreased ($P = 0.033$) average daily feed intake (ADFI) and improved ($P = 0.033$) F/G compared to corn-SBM-based diets. Finally, ADG increased (linear, $P = 0.001$) and F/G improved (quadratic, $P = 0.007$) as SBM level increased from 21 to 35%. In conclusion, decreased growth performance indicates that the nutrient profile of the HP DDGS may have been overestimated. The net energy of conventional and Lincolnway DDGS seemed to be underestimated due to the improved F/G compared to corn-SBM diets. Finally, feeding diets with increasing SBM resulted in improved growth performance in late nursery pigs.

Keywords

distillers dried grains, growth performance, nursery pig, soybean meal

Cover Page Footnote

The authors thank Lincolnway Energy, LLC (Nevada, IA) for partial financial support and New Horizon Farms (Pipestone, MN) for providing animals, research facilities, and technical support.

Authors

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Effects of Distillers Dried Grains with Solubles Sources and Soybean Meal Level on Growth Performance of Late Nursery Pigs[1]

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Summary

Two experiments were conducted to determine the effects of distillers dried grains with solubles (DDGS) source and soybean meal (SBM) level on growth performance of late nursery pigs. A total of 1,064 and 1,011 pigs (PIC 280 × 1050), initially 23.1 and 24.1 lb body weight (BW), were used in Exp. 1 and 2, respectively, with 21 to 27 pigs per pen. For approximately 21 days after weaning, pigs were fed common phase 1 and 2 diets. Then, pens were assigned to treatments in a randomized complete block design. There were 6 treatments in each experiment with 7 pens per treatment. Treatments 1 to 5 were replicated in Exp. 1 and 2, whereas treatment 6 was fed only in Exp. 1 and treatment 7 was fed only in Exp. 2. Treatments 1 to 3 consisted of diets with 23% conventional DDGS (Valero, Aurora, SD) and 21, 27, or 35% SBM. Treatments 4 and 5 were corn-SBM-based diets with 27 or 35% SBM. Treatment 6 consisted of a corn-SBM-based diet with 20% high protein DDGS (HP DDGS; Purestream 40, Lincolnway Energy, LLC, Nevada, IA) replacing the 23% conventional DDGS with the same amount of SBM (21%) as treatment 1 and same neutral detergent fiber (NDF) as treatment 2. Finally, treatment 7 consisted of a diet similar to treatment 2 but with 23% Lincolnway DDGS (Lincolnway Energy, LLC, Nevada, IA) replacing the 23% conventional DDGS. Data were analyzed with the GLIMMIX procedure of SAS. There was no evidence for treatment × experiment interactions, thus data from treatments 1 to 5 were combined. In Exp. 1, pigs fed diets containing HP DDGS had decreased ($P < 0.01$) average daily gain (ADG) and poorer ($P < 0.01$) feed-to-gain ratio (F/G) compared to pigs fed diets with conventional DDGS at the same NDF level, conventional DDGS at the same SBM level, or corn-SBM diet. In Exp. 2, there was no evidence for differences ($P > 0.10$) in performance of pigs fed diets with Lincolnway DDGS or conventional DDGS. Feeding diets with 23% conventional DDGS decreased ($P = 0.033$) average daily feed intake (ADFI) and improved ($P = 0.033$) F/G compared to corn-SBM-based diets. Finally, ADG increased (linear, $P = 0.001$) and F/G

[1]The authors thank Lincolnway Energy, LLC (Nevada, IA) for partial financial support and New Horizon Farms (Pipestone, MN) for providing animals, research facilities, and technical support.
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improved (quadratic, $P = 0.007$) as SBM level increased from 21 to 35%. In conclusion, decreased growth performance indicates that the nutrient profile of the HP DDGS may have been overestimated. The net energy of conventional and Lincolnway DDGS seemed to be underestimated due to the improved F/G compared to corn-SBM diets. Finally, feeding diets with increasing SBM resulted in improved growth performance in late nursery pigs.

Introduction

Distillers dried grains with solubles is a co-product of the ethanol industry widely used in swine diets. Recently, new technologies are being developed that result in HP DDGS which contains approximately 40% crude protein. Research on the effects of HP DDGS on growth performance is scarce. In a recent study by Yang et al.,[5] pigs fed diets with up to 30% Purestream 40 (Lincolnway Energy, LLC, Nevada, IA), a source of HP DDGS, had poorer ADG, ADFI, and F/G. As these results were not expected, we speculate that they were driven by overestimating amino acid content and digestibility, imbalances between amino acids, or NDF content of this novel source of HP DDGS.

Soybean meal (SBM) is a major component of swine diets. It is the most used plant-protein source in swine diets, mainly due to its high digestibility and amino acid profile that complements corn, and consistent processing that removes anti-nutritional factors.[6,7] However, in recent years, U.S. swine diets are formulated with increasing crystalline amino acid amounts and alternative ingredients, such as DDGS or HP DDGS. This is done at the expense of SBM in order to reduce diet cost while still meeting the animals' nutrient requirements. However, recent research suggests that there may be some benefits of feeding high levels of SBM, especially for health-challenged pigs.[8,9] Therefore, we hypothesized that pigs fed diets with high DDGS or HP DDGS inclusions or high crystalline amino acid amounts may have reduced growth performance due to the reduction in dietary SBM. The objective of this study was to evaluate two DDGS sources, a HP DDGS source, and SBM level on growth performance of late nursery pigs.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocols used in these experiments. Two experiments were conducted at a commercial nursery research facility in southwest Minnesota. The barns were mechanically ventilated and had completely slatted flooring. Each pen (12.1 × 7.5 ft) was

[5]Yang, Z., P.E. Urriola, A.M. Hilbrands, L.J. Johnston, and G.C. Shurson. 2018. Effects of increasing dietary concentrations of high protein distillers dried grains (HP-DDG) on growth performance of nursery pigs. J. Anim. Sci. 96 (E-Suppl. 2):137-138. (Abstr.)

[6]NRC. 2012. Nutrient requirements of swine. 11th rev. ed. Natl. Acad. Press, Washington, DC.

[7]Pettigrew, J. E., K. T. Soltwedel, J. C. Miguel, and M. F. Palacios. 2017. Soybean Meal Information Center Fact Sheet: Soybean Use - Swine. Soybean Meal Inf. Cent. Available at: https://www.soymeal.org/resources/soybean-use-swine.

[8]Johnston, M. E., R. D. Boyd, C. Zier-Rush, and C. E. Fralick. 2010. Soybean meal level modifies the impact of high immune stress on growth and feed efficiency in pigs. J. Anim. Sci. 88(E-Suppl. 3):57-58. (Abstr.)

[9]Rochell, S.J., L.S. Alexander, G.C. Rocha, W.G. Van Alstine, R.D. Boyd, J.E. Pettigrew, and R.N. Dilger. 2015. Effects of dietary soybean meal concentration on growth and immune response of pigs infected with porcine reproductive and respiratory syndrome virus. J. Anim. Sci. 93:2987-2997.

equipped with a 6-hole, stainless steel, dry self-feeder and a pan waterer. Experimental diets were manufactured at New Horizon Farms feed mill in Pipestone, MN. Feed additions were delivered and recorded by a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN). Representative diet samples were obtained from each treatment. Samples were analyzed for dry matter (DM), crude protein (CP), Ca, P, Na, and Cl (Ward Laboratories, Inc., Kearney, NE).

In Exp. 1, 1,064 pigs (PIC 280 × 1050; initial average BW of 23.1 lb) were used in a 27-d growth trial with 22 to 27 pigs per pen and 7 replicates per treatment. In Exp. 2, 1,011 pigs (PIC 280 × 1050; initial average BW of 24.1 lb) were used in a 27-d growth trial with 21 to 27 pigs per pen and 7 replicates per treatment. Pigs were sourced from two sow farms and weaned at approximately 19 and 20 d of age in Exp. 1 and 2, respectively. In both experiments, the barn was filled in two days. Pigs were fed common phase 1 and 2 diets for approximately 21 d after placement and before the start of the experiments. Then, pens of pigs were allotted to treatments in a randomized complete block design with BW, sow farm, and fill date as the blocking factors.

Each experiment had 6 treatments. Treatments 1 to 5 were replicated in Exp. 1 and 2, whereas treatment 6 was fed only in Exp. 1 and treatment 7 was fed only in Exp. 2. Treatments 1 to 3 consisted of diets with 23% conventional DDGS (Valero, Aurora, SD) with 21, 27, or 35% SBM. Treatments 4 and 5 were corn-SBM-based diets with 27 or 35% SBM. Treatment 6 consisted of a corn-SBM diet with 20% HP DDGS (Purestream 40, Lincolnway Energy, LLC, Nevada, IA) replacing the 23% conventional DDGS with the same SBM level as treatment 1 and same NDF as treatment 2. Finally, treatment 7 was a diet similar to treatment 2 but with 23% Lincolnway DDGS (Lincolnway Energy, LLC, Nevada, IA) replacing the 23% conventional DDGS. Soybean meal levels were obtained by manipulating the inclusion of crystalline amino acids (Table 1). Conventional DDGS contained 7.5% oil, 28.2% crude protein, 33.5% NDF, and 1,072 kcal/lb estimated net energy. High protein DDGS contained 5.3% oil, 36.8% crude protein, 34.7% NDF, and 1,227 kcal/lb estimated net energy. Lincolnway DDGS contained 5.6% oil, 30.3% crude protein, 34% NDF, and 975 kcal/lb estimated net energy. Net energy values for DDGS sources were estimated based on oil content (Graham et al., 2014[10]). Net energy values for corn and SBM were 1,212 and 1,067 kcal/lb, respectively. All diets were formulated to be isocaloric in net energy by manipulating the inclusion of tallow. Standardized ileal digestibility of amino acids for HP DDGS were obtained from Espinosa and Stein.[11]

Pens were weighed and feed disappearance was measured on d 0, 7, 14, 21, and 27 in Exp. 1 and 2 to determine ADG, ADFI, and F/G. Data were analyzed as a randomized complete block design with block as a random effect and pen as the experimental unit. Treatment × experiment interactions were tested for treatments 1 to 5. Pre-planned contrast statements were constructed to evaluate the following effects:

[10]Graham, A.B., R.D. Goodband, M.D. Tokach, S.S. Dritz, J.M. DeRouchey, S. Nitikanchana, and J.J. Updike. 2014. The effects of low-, medium-, and high-oil distillers dried grains with solubles on growth performance, nutrient digestibility, and fat quality in finishing pigs. J. Anim. Sci. 92:3610-3623.
[11]Espinosa, C.D. and H.H. Stein. 2018. High-protein distillers dried grains with solubles produced using a novel front-end-back-end fractionation technology has greater nutritional value than conventional distillers dried grains with solubles when fed to growing pigs. J. Anim. Sci. 96:1869-1876.

1. HP DDGS vs. conventional DDGS at the same NDF level (Exp. 1; treatment 6 vs. 2)
2. HP DDGS vs. conventional DDGS at the same SBM level (Exp. 1; treatment 6 vs. 1)
3. HP DDGS vs. SBM (Exp. 1; treatment 6 vs. 5)
4. Lincolnway DDGS vs. conventional DDGS at the same NDF level (Exp. 2; treatment 7 vs. 2)
5. Conventional DDGS inclusion (Exp. 1 and 2; treatments 2 and 3 vs. 4 and 5)
6. SBM level, 27 vs. 35% (Exp. 1 and 2; treatments 2 and 4 vs. 3 and 5)
7. SBM titration, linear (Exp. 1 and 2; treatments 1, 2, and 3)
8. SBM titration, quadratic (Exp. 1 and 2; treatments 1, 2, and 3)

Contrast coefficients were adjusted for unequally spaced SBM level. Data were analyzed using the GLIMMIX procedure of SAS 9.4 (SAS Institute Inc., Cary, NC). Results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

The proximate analysis of the DDGS sources and diets were consistent with formulated estimates (Tables 2 and 3).

In Exp. 1, pigs fed diets with HP DDGS had decreased ($P < 0.01$) ADG and poorer ($P < 0.01$) F/G compared to pigs fed diets with conventional DDGS at the same NDF level, conventional DDGS at same SBM level, or corn-SBM diet (Table 4 and 5). Results suggest that nutrient loadings for HP DDGS, such as amino acid content or digestibility, may be overestimated.

In Exp. 2, there was no evidence for differences ($P > 0.10$) in performance of pigs fed diets with Lincolnway DDGS or conventional DDGS (Table 6).

Because there was no evidence for treatment × experiment interaction ($P > 0.10$), data from treatments 1 to 5 from each experiment were combined (Tables 7 and 8). Feeding diets with 23% conventional DDGS decreased ($P = 0.033$) ADFI and improved ($P = 0.033$) F/G compared to corn-SBM diets. This suggests that the net energy of conventional DDGS, calculated as approximately 88% of corn net energy, was underestimated in diet formulation. Based on caloric efficiency, determined as kcal net energy required per pound of gain, the net energy of the conventional DDGS used in this study was approximately 93% of the net energy of corn. Furthermore, the lack of evidence for differences between pigs fed conventional DDGS and Lincolnway DDGS in Exp. 2 indicates that net energy of the latter was also underestimated.

When analyzed as part of the factorial without or with 23% conventional DDGS, pigs fed diets with 35% SBM had marginally greater ($P = 0.052$) ADG and improved ($P = 0.001$) F/G compared to pigs fed diets with 27% SBM. When comparing SBM level to diets with 23% conventional DDGS, ADG increased (linear, $P = 0.001$) and F/G improved (quadratic, $P = 0.007$) with increasing SBM, and the response was mainly driven by the treatment with 35% SBM. Researchers have suggested pigs under health challenge have better performance when fed high SBM level inclusions.[7,8]

Although not fully understood, some of the benefits have been attributed to anti-inflammatory and immune system modulation abilities of isoflavones and saponins present in SBM.[12]

In conclusion, it seems that nutrient loadings of HP DDGS were overestimated, which resulted in poorer growth performance when replacing SBM or conventional DDGS. Pigs fed diets with conventional DDGS had improved F/G, which indicates that the net energy was underestimated in conventional and Lincolnway DDGS. Finally, feeding increasing SBM levels resulted in improved performance in late nursery pigs. Future research should focus on reevaluating HP DDGS with an updated nutrient profile, and to better understand the potential benefits of high levels of SBM on growth performance of late nursery pigs.

[12]Smith, B.N. and R.N. Dilger. 2018. Board invited review: immunomodulatory potential of soybean-derived isoflavones and saponins in pigs. J. Anim. Sci. 96:1288-1304.

Table 1. Diet composition (as-fed basis)[1,2]

Treatment:	1	2	3	4	5	6	7
Soybean meal:	21%	27%	35%	27%	35%	21%	27%
DDGS:	23%	23%	23%	0%	0%	20%	23%
DDGS source[3]:	Conventional	Conventional	Conventional	---	---	HP DDGS	Lincolnway
Ingredients, %							
Corn	49.06	43.16	35.56	66.66	59.29	53.70	42.15
Soybean meal, 47% crude protein	21.19	27.14	34.70	27.17	34.71	21.14	27.06
DDGS, conventional	23.00	23.00	23.00	---	---	---	---
DDGS, Lincolnway	---	---	---	---	---	---	23.00
HP DDGS, Purestream 40	---	---	---	---	---	20.00	---
Tallow	3.05	3.55	4.15	2.05	2.65	1.52	4.65
Monocalcium phosphate, 21.5% P	0.65	0.55	0.45	1.10	0.95	0.90	0.55
Calcium carbonate	1.15	1.15	1.13	0.98	0.95	1.10	1.23
Sodium chloride	0.55	0.55	0.55	0.65	0.65	0.65	0.40
L-Lysine HCl	0.69	0.50	0.27	0.59	0.35	0.55	0.50
DL-Methionine	0.14	0.09	0.02	0.21	0.15	0.09	0.09
L-Threonine	0.20	0.12	0.02	0.24	0.13	0.13	0.17
L-Tryptophan	0.07	0.03	---	0.06	0.01	0.06	0.02
L-Valine	0.10	---	---	0.15	---	---	0.03
Vitamin-trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[4]	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

continued

Table 1. Diet composition (as-fed basis)[1,2]

Treatment:	1	2	3	4	5	6	7
Soybean meal:	21%	27%	35%	27%	35%	21%	27%
DDGS:	23%	23%	23%	0%	0%	20%	23%
DDGS source[3]:	Conventional	Conventional	Conventional	---	---	HP DDGS	Lincolnway
Standardized ileal digestible (SID) amino acids, %							
Lysine	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Isoleucine:lysine	54	62	71	52	61	61	58
Leucine:lysine	131	142	156	109	123	150	138
Methionine:lysine	34	32	30	36	34	32	30
Methionine & cystine:lysine	56	56	56	56	56	56	56
Threonine:lysine	62	62	62	62	62	62	62
Tryptophan:lysine	19.3	19.1	20.1	19.2	19.0	19.1	19.1
Valine:lysine	69	69	79	68	66	70	67
Net energy, kcal/lb	1,182	1,182	1,182	1,182	1,182	1,182	1,182
Crude protein, %	21.0	23.1	25.8	18.6	21.2	21.9	23.5
Neutral detergent fiber, %	14.2	14.0	13.6	8.8	8.5	14.0	14.0
Calcium, %	0.72	0.73	0.75	0.74	0.74	0.72	0.74
STTD P,[5] %	0.45	0.45	0.45	0.45	0.45	0.45	0.45

[1]Treatments 1 to 5 were fed in Exp. 1 and 2. Treatments 6 and 7 were fed only in Exp. 1 and 2, respectively.
[2]In Exp. 1, diets were fed from 23.1 to 53.9 lb body weight (BW). In Exp. 2, diets were fed from 24.1 to 57.4 lb BW.
[3]DDGS = distillers dried grains with solubles. HP DDGS = high protein distillers dried grains with solubles.
[4]Optiphos 2000 (Huvepharma Inc, Peachtree City, GA) provided 237 FTU per lb of feed.
[5]STTD = standardized total tract digestible phosphorus.

Table 2. Chemical analysis of distillers dried grains with solubles (DDGS) sources (as-fed basis)[1]

	DDGS source	
Item	Conventional DDGS	Lincolnway DDGS
Proximate analysis, %		
Dry matter	89.0	88.0
Crude protein	29.0	29.2
Ether extract	8.4	7.3
Neutral detergent fiber	27.4	30.3
Calcium	0.08	0.10
Phosphorus	0.72	0.84
Sodium	0.11	0.13
Chloride	0.18	0.21

[1]A representative sample of each source was collected, homogenized, and submitted to Ward Laboratories, Inc., Kearney, NE, for proximate analysis.

Table 3. Chemical analysis of diets (as-fed basis)[1]

Treatment:	1	2	3	4	5	6	7
Soybean meal:	21%	27%	35%	27%	35%	21%	27%
DDGS:	23%	23%	23%	0%	0%	20%	23%
DDGS source[2]:	Conventional	Conventional	Conventional	---	---	HP DDGS	Lincolnway
Proximate analysis, %							
Dry matter	88.7	88.6	88.8	87.6	88.5	88.5	88.4
Crude protein	22.3	23.2	25.8	18.6	21.1	22.3	22.7
Ether extract	6.2	6.3	6.9	4.0	4.0	5.4	7.9
Neutral detergent fiber	10.7	11.4	11.0	5.7	6.3	10.6	13.0
Calcium	0.74	0.82	0.73	0.85	0.83	0.75	0.66
Phosphorus	0.58	0.57	0.60	0.56	0.58	0.58	0.59
Sodium	0.32	0.40	0.29	0.39	0.36	0.33	0.23
Chloride	0.49	0.61	0.44	0.60	0.55	0.50	0.36

[1]A representative sample of each diet was collected from each treatment, homogenized, and submitted to Ward Laboratories, Inc., Kearney, NE for proximate analysis.
[2]DDGS = distillers dried grains with solubles. HP DDGS = high protein distillers dried grains with solubles.

Table 4. Effects of distillers dried grains with solubles (DDGS) source and level and increasing soybean meal on growth performance of nursery pigs, Exp. 1[1,2]

Treatment:	1	2	3	4	5	6	
Soybean meal:	21%	27%	35%	27%	35%	21%	
DDGS:	23%	23%	23%	---	---	20%	
DDGS source:	Conventional	Conventional	Conventional	---	---	HP DDGS	SEM
BW,[3] lb							
d 0	23.1	23.1	23.1	23.1	23.1	23.1	0.790
d 27	53.0	53.8	55.4	55.4	54.6	51.3	1.449
d 0 to 27							
ADG,[4] lb	1.10	1.12	1.19	1.19	1.17	1.03	0.029
ADFI,[5] lb	1.67	1.69	1.72	1.80	1.70	1.64	0.052
F/G[6]	1.51	1.50	1.44	1.51	1.46	1.59	0.015

[1]A total of 1,064 pigs (initial BW = 23.1 lb) were used in a 27-d nursery trial with 22 to 27 pigs per pen and 7 replicates per treatment.
[2]Diets were isocaloric (net energy = 1,182 kcal/lb) and were formulated with 4.99 g Lys/Mcal net energy (1.30% SID Lys).
[3]BW = body weight.
[4]ADG = average daily gain.
[5]ADFI = average daily feed intake.
[6]F/G = feed-to-gain ratio.

Table 5. Contrast statements, Exp. 1

Item[2]	HP DDGS vs. conventional DDGS at the same NDF (6 vs. 2)[1]	HP DDGS vs. conventional DDGS at the same soybean meal (6 vs. 1)	HP DDGS vs. soybean meal (6 vs. 5)
BW, lb			
d 0	0.987	0.908	0.961
d 27	0.022	0.120	0.004
d 0 to 27			
ADG, lb	0.004	0.018	0.001
ADFI, lb	0.250	0.465	0.146
F/G	0.001	0.001	0.001

[1]DDGS = distillers dried grains with solubles. HP DDGS = high protein distillers dried grains with solubles. NDF = neutral detergent fiber.
[2]BW = body weight. ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio.

Table 6. Effects of distillers dried grains with solubles (DDGS) source and level and soybean meal level on growth performance of nursery pigs, Exp. 2[1,2]

Treatment:	1	2	3	4	5	7		Probability, *P* =
Soybean meal:	21%	27%	35%	27%	35%	27%		Lincolnway vs conventional DDGS at the same NDF (7 vs. 2)
DDGS:	23%	23%	23%	---	---	23%		
DDGS source:	Conventional	Conventional	Conventional	---	---	Lincolnway	SEM	
BW,[3] lb								
d 0	24.1	24.1	24.1	24.1	24.1	24.1	0.477	0.857
d 27	56.7	56.8	57.8	57.6	57.8	57.4	0.865	0.462
d 0 to 27								
ADG,[4] lb	1.21	1.20	1.24	1.23	1.25	1.23	0.027	0.272
ADFI,[5] lb	1.78	1.77	1.77	1.85	1.79	1.81	0.040	0.368
F/G[6]	1.48	1.48	1.42	1.50	1.43	1.47	0.012	0.836

[1]A total of 1,011 pigs (initial BW = 24.1 lb) were used in a 27-d nursery trial with 21 to 27 pigs per pen and 7 replicates per treatment.
[2]Diets were isocaloric (net energy = 1,182 kcal/lb) and were formulated with 4.99 g Lys/Mcal net energy (1.30% SID Lys).
[3]BW = body weight.
[4]ADG = average daily gain.
[5]ADFI = average daily feed intake.
[6]F/G = feed-to-gain ratio.

Table 7. Effects of distillers dried grains with solubles (DDGS) source and level and soybean meal level on growth performance of nursery pigs, Exp. 1 and 2 combined[1,2]

Treatment:	1	2	3	4	5	
Soybean meal:	21%	27%	35%	27%	35%	
DDGS:	23%	23%	23%	---	---	
DDGS source:	Conventional	Conventional	Conventional	---	---	SEM
BW,[3] lb						
d 0	23.6	23.6	23.6	23.6	23.6	0.482
d 27	54.8	55.3	56.6	56.5	56.2	0.940
d 0 to 27						
ADG,[4] lb	1.16	1.16	1.22	1.21	1.21	0.022
ADFI,[5] lb	1.72	1.73	1.74	1.82	1.75	0.035
F/G[6]	1.49	1.49	1.43	1.51	1.44	0.009

[1]A total of 2,075 pigs (initial BW = 23.1 or 24.1 lb) were used in a 27-d nursery trial with 21 to 27 pigs per pen and 14 replicates per treatment.
[2]Diets were isocaloric (net energy = 1,182 kcal/lb) and were formulated with 4.99 g Lys/Mcal net energy (1.30% SID Lys).
[3]BW = body weight.
[4]ADG = average daily gain.
[5]ADFI = average daily feed intake.
[6]F/G = feed-to-gain ratio.

Table 8. Contrast statements, Exp. 1 and 2 combined[1]

Item[2]	Conventional DDGS level (2+3 vs. 4+5)[3]	Soybean meal level (2+4 vs. 3+5)	Soybean meal level, linear (1, 2, 3)	Soybean meal level, quadratic (1, 2, 3)
BW, lb				
d 0	0.951	0.971	0.982	0.956
d 27	0.404	0.258	0.007	0.584
d 0 to 27				
ADG, lb	0.165	0.052	0.001	0.200
ADFI, lb	0.033	0.152	0.525	0.905
F/G	0.033	0.001	0.001	0.007

[1]No treatment × experiment interactions were observed and data from both experiments were combined.
[2]BW = body weight. ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio.
[3]DDGS = distillers dried grains with solubles.