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Effect of Corn Dried Distillers Grains with Solubles (DDGS) on Growth Performance and Carcass Characteristics of Growing-Finishing Gilts with Previous Exposure to DDGS in the Nursery

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The inclusion of high concentrations of DDGS (30%) in both the nursery and growing-finishing periods may result in negative effects on growth performance and carcass characteristics.

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Summary

The objective of this experiment was to evaluate the effects of high concentrations of distillers dried grains with solubles (DDGS; 30%) on growth performance and carcass characteristics of gilts, during growing-finishing, that were previously fed high concentrations of DDGS during the nursery phase. Overall (week 1 to 16), the following observations are noteworthy: 1) among pigs that were fed DDGS in the nursery, average daily gain (ADG) and final body weight (BW) tended ($P < 0.10$) to be lower during growing-finishing compared to pigs that did not receive DDGS in the nursery; 2) among pigs that received DDGS during growing-finishing, ADG tended ($P < 0.10$) to be lower compared to pigs that did not receive DDGS during growing-finishing; and 3) among pigs that received DDGS in both the nursery and during growing-finishing, ADG and final BW was decreased ($P < 0.04$) compared to pigs with no prior exposure to DDGS. With respect to carcass characteristics, 10th-rib back fat was greater ($P < 0.05$) at the end of finisher 2 among pigs that did not receive DDGS in the nursery and hot carcass weight tended ($P < 0.07$) to be decreased among pigs that received DDGS in both the nursery and during growing-finishing. This research indicates that the inclusion of high concentrations of DDGS in both the nursery and growing-finishing periods may result in negative effects on growth performance and carcass characteristics.

Introduction

Distillers dried grains with solubles (DDGS) is the primary co-product of ethanol production that is used in the pork industry. It has been estimated that approximately 15% of the DDGS that is produced is used in the pork industry, with the majority utilized in growing-finishing diets. Previous research with growing-finishing pigs has shown that the addition of DDGS up to 10% of the diet results in similar growth performance when compared to typical corn-soybean meal diets (Table 1). However, with the inclusion of DDGS in excess of 10%, growth performance may be compromised if diets are not formulated on a digestible amino acid basis. Less emphasis has been placed on utilization of DDGS during the nursery period and, to our knowledge, no experiments have been conducted to evaluate the growth performance of growing-finishing pigs that were exposed to high concentrations of DDGS during the nursery phase of production. The objective of this experiment was to evaluate the effects of high concentrations of DDGS (30%) on growth performance and carcass characteristics of gilts, during the growing-finishing phase, that were previously fed high concentrations of DDGS (30%) during the nursery phase.

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Table 1. Effect of dietary DDGS level on overall growth performance of growing-finishing pigs.[a]

	DDGS, %			
Item	0	10	20	30
ADG, lb	1.90[a]	1.90[a]	1.83[bc]	1.79[bd]
ADFI, lb	5.25	5.22	5.09	5.18
G:F, lb/lb	0.36[a]	0.36[a]	0.36[a]	0.34[b]
Final BW, lb	257.93[a]	258.93[a]	251.94[b]	246.94[b]

[a,b]Means within a row with unlike superscripts are different ($P < 0.05$)
[c,d]Means within a row with unlike superscripts are different ($P < 0.10$)
Shurson, J. 2006. 67th Minnesota Nutrition Conference, St. Paul, Minn.

Table 2. Composition of growing-finishing diets (as-fed basis) %.

	Grower 1 (week 1 to 3)		Grower 2 (week 4 to 8)		Finisher 1 (week 9 to 12)		Finisher 2 (week 13 to 16)	
	DDGS[a], %							
Item, %	0	30	0	30	0	30	0	30
Corn	69.2	55.8	73.1	58.5	78.7	63.8	84.7	64.1
Soybean meal, 47.5% CP	25.5	8.7	22.0	6.3	16.7	1.5	10.8	1.5
Tallow	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Dicalcium phosphate	1.3	0.7	0.9	0.4	0.7	0.1	0.7	0.0
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Limestone	0.8	1.3	0.8	1.1	0.8	1.3	0.8	1.2
Vitamin premix[b]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Trace mineral mix[c]	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
L-Lysine•HCl	0.1	0.4	0.1	0.5	0.1	0.3	0.1	0.1
L-Tryptophan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L-Threonine	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
DDGS[c]	0.0	30.0	0.0	30.0	0.0	30.0	0.0	30.0
Analyzed Composition								
CP[d], %	16.83	16.08	16.19	15.12	14.12	13.57	12.13	13.79
EE[e], %	4.95	7.06	4.45	6.91	5.04	7.53	5.41	7.91
Calculated Composition								
Lysine, %	1.0	1.0	0.9	0.9	0.8	0.8	0.6	0.6
CP[d], %	18.0	18.0	16.6	16.6	14.5	15.2	12.2	15.0
ME[f], kcal/lb	1554	1625	1561	1478	1566	1639	1569	1645

[a]DDGS = Corn dried distillers grains 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 0.1% inclusion: Zn (as ZnS_4O), 85 mg; Fe (as $FeSO_4•H_2O$), 85 mg; Mn (as (MnO), 20 mg; Cu (as $CuSO_4•5H_2O$), 7 mg; I (as $Ca(IO_3)•H_2O$, 0.17 mg; Se (as Na_2SeO_3), 0.17 mg
[d]CP = Crude Protein
[e]EE = Ether extract
[f]ME = Metabolizable energy

Materials and Methods

Animals

The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee of the University of Nebraska–Lincoln. Twenty gilts [(Danbred × NE white line) × Danbred] were sorted by weight and randomly allotted to one of four dietary treatments in a 16-week experiment that was conducted at the University of Nebraska–Lincoln. Pigs (average initial BW 61.97 ± 1.6 lb) were individually housed in pens (6.3 × 3.4 ft) with wire flooring, one nipple waterer, and one stainless steel feeder under constant lighting in a temperature controlled room. Pigs had ad libitum access to feed and water. There were four treatments with one pig/pen and five replicates/treatment.

Treatments

Pigs utilized in the current experiment either had no previous exposure to DDGS or were previously exposed to 30% DDGS during phase 3 of the nursery period *(2008 Nebraska Swine Report)*. Among pigs that were fed 0% DDGS in the nursery, growing-finishing diets for the current experiment were formulated to provide either 0% DDGS (Treatment 1) or 30% DDGS (Treatment 2). Among pigs that were fed 30% DDGS in the nursery, growing-finishing diets for the current experiment were formulated to provide either 0% (Treatment 3) or 30% DDGS (Treatment 4). All diets were formulated on a total amino acid basis, fed in meal form and formulated to meet or exceed NRC requirements for growth (Table 2).

Data and Sample Collection

Pigs and feeders were weighed at the beginning of the experiment and biweekly thereafter. Feed disappearance was calculated using the difference between feed offered and feed remaining in the feeder at the end of each biweekly period. Body weight (BW) gain was calculated using the pig weight at the beginning and at the end of each biweekly period. Average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (G:F) were calculated based on the individual biweekly BW gain and feed disappearance. At the beginning of the experiment and at the end of Grower 1 (week 3), Grower 2 (week 8), Finisher 1 (week 12), and Finisher 2 (week 16), ultrasound was used to measure backfat thickness (BF) and longissimus muscle area (LMA) at the 10th rib. Carcass measurements (hot carcass weight, HCW; dressing percentage, DP; last-rib backfat, LRBF; 10th-rib BF; and LMA) were obtained at slaughter.

Statistical Analyses

Growth data were analyzed as a completely randomized design using the MIXED procedure of SAS. The main effect of the statistical models was dietary treatment. Pen was con-

Table 3. Body weights (BW), average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (G:F) of nursery pigs fed 0 or 30% DDGS without (Treatment 1 and 2) or with (Treatments 3 and 4) previous exposure to DDGS (30%) during the nursery period.

Treatment	1	2	3	4				
	DDGS[a], %							
Nursery	0	0	30	30				
Growing-Finishing	0	30	0	30				
						P-value		
Item					SEM[b]	1[c]	2[d]	3[e]
No. of pigs	5	5	5	5				
Initial BW, lb	63.41	62.99	59.49	61.98	1.61	0.12	0.57	0.29
Final BW, lb	270.2	250.6	248.2	235.6	9.70	**0.08**	0.11	**0.04**
Grower 1 (week 1 to 3)								
ADG[f], lb	1.56	1.45	1.70	1.48	0.18	0.66	0.37	0.93
ADFI[g], lb	3.95	3.70	3.75	3.75	0.35	0.73	0.56	0.39
G:F[h], lb/lb	0.40	0.39	0.45	0.39	0.01	0.44	0.34	0.70
Grower 2 (week 4 to 8)								
ADG, lb	2.40	2.27	1.92	2.12	0.13	**0.02**	0.84	**0.05**
ADFI, lb	5.36	4.74	4.34	5.11	0.35	0.13	0.71	**0.02**
G:F, lb/lb	0.45	0.49	0.44	0.43	0.01	0.15	0.90	0.84
Finisher 1 (week 9 to 12)								
ADG, lb	2.14	1.87	2.14	1.85	0.20	0.94	0.20	0.42
ADFI, lb	6.17	5.47	5.22	5.69	0.35	0.38	0.75	0.14
G:F, lb/lb	0.36	0.34	0.42	0.33	0.01	0.51	0.18	0.81
Finisher 2 (week 13 to 16)								
ADG, lb	2.05	1.83	1.85	1.50	0.18	0.14	0.13	0.13
ADFI, lb	6.15	6.22	5.60	5.60	0.35	0.25	0.95	0.55
G:F, lb/lb	0.34	0.30	0.32	0.25	0.01	0.30	**0.01**	**0.06**
Overall (week 1 to 16)								
ADG, lb	2.09	1.92	1.92	1.76	0.09	**0.10**	**0.08**	**0.04**
ADFI, lb	5.62	5.22	4.87	5.22	0.24	0.14	0.93	**0.08**
G:F, lb/lb	0.39	0.38	0.40	0.34	0.01	0.66	**0.01**	0.50

[a]DDGS = Corn dried distillers grains with solubles
[b]SEM = Standard error of the mean
[c]*P*-value: Orthogonal contrast to evaluate the effect of DDGS inclusion in the nursery [(1 + 2) vs. (3 + 4)]
[d]*P*-value: Orthogonal contrast to evaluate the effect of DDGS inclusion in growing-finishing [(1 + 3) vs. (2 + 4)]
[e]*P*-value: Orthogonal contrast to evaluate the effect of DDGS inclusion in the nursery [(1) vs. (2 + 3 + 4)]
[f]ADG = Average daily gain
[g]ADFI = Average daily feed intake
[h]G:F = Gain to feed ratio

sidered as the experimental unit and was considered as a random effect. In addition, orthogonal contrasts were utilized to evaluate the effect of previous inclusion of DDGS in the nursery (Treatments 1 and 2 vs. 3 and 4), to evaluate the effect of including DDGS during the growing-finishing period (Treatments 1 and 3 vs. 2 and 4), and to evaluate the effect of DDGS inclusion in both the nursery and during growing-finishing (Treatment 1 vs. 2, 3, and 4) on growth performance and carcass characteristics during the growing-finishing period.

Results and Discussion

Pig growth performance and BW results are summarized in Table 3. During Grower 1, growth performance was not affected by dietary treatment. During Grower 2, G:F was not affected by dietary treatment; however, ADG was decreased ($P < 0.02$) among pigs that received DDGS in the nursery (Treatments 3 and 4) compared to pigs that did not receive DDGS in the nursery (Treatments 1 and 2), and ADG and ADFI were decreased ($P < 0.05$ and 0.02, respectively for ADG and ADFI) in pigs that received DDGS (Treatments 2, 3, and 4) compared to pigs with no previous exposure to DDGS (Treatment 1).

During Finisher 1, growth performance was not affected by dietary treatment. During Finisher 2, ADG and ADFI were not affected by dietary treatment; however, G:F was greater ($P < 0.01$) for pigs that did not receive DDGS during growing-finishing (Treatments 1 and 3) compared to pigs that did receive DDGS during growing finishing (Treatments 2 and 4), and G:F tended ($P < 0.06$) to be greater for pigs with no prior exposure to DDGS (Treatment 1) compared to pigs that received DDGS during the nursery and growing-finishing (Treatments 2, 3, and 4). Overall, the following observations were made: 1) among pigs that were fed DDGS in the nursery, ADG and final BW tended ($P < 0.10$) to be lower during growing-finishing compared to pigs that did not receive DDGS in the nursery; 2) among pigs that received DDGS during growing-finishing, ADG tended ($P < 0.10$) to be lower compared to pigs that did not receive DDGS during growing-finishing; 3) among pigs that received DDGS in both the nursery and/or during growing-finishing, ADG and final BW was decreased ($P < 0.04$) and ADFI tended ($P < 0.08$) to be decreased compared to pigs with no prior exposure to DDGS; and 4) among pigs that did not receive DDGS during growing-finishing, G:F was greater ($P < 0.01$) compared to pigs that did receive DDGS during growing-finishing. Final BW were 270.2, 250.6, 248.2, and 235.6 lb, respectively, for Treatments 1, 2, 3 and 4.

Carcass characteristics are summarized in Table 4. Carcass measurements taken at slaughter (dressing percentage, last-rib BF, 10th-rib BF, and LMA) were not affected by dietary treatment; however, hot carcass weight tended ($P < 0.07$) to be decreased among pigs that received DDGS in both the nursery and during growing-finishing. Similar to final BW, live weight at slaughter tended ($P < 0.10$)

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to be decreased for growing-finishing pigs that received DDGS during the nursery period (Treatments 3 and 4) compared to pigs with no previous exposure to DDGS (Treatment 1 and 2). In addition, among pigs that received DDGS in both the nursery and/or during growing-finishing, live weight at slaughter was decreased ($P < 0.04$), compared to pigs with no prior exposure to DDGS. Ultrasound measurements taken at the end of Grower 1, Grower 2, Finisher 1, and Finisher 2 were not affected by dietary treatment with the exception of 10^{th}-rib BF. At the end of Finisher 2, 10^{th}-rib back fat was greater ($P < 0.05$) among pigs that did not receive DDGS in the nursery compared to pigs that received DDGS in the nursery.

Conclusions

This research indicates that feeding high concentrations of DDGS (30%) during the growing-finishing phase may not negatively affect growth performance. However, transient negative effects on overall ADG and final BW during the growing-finishing period may be observed in pigs that are fed high concentrations of DDGS in both the nursery and during growing-finishing.

[1]Thomas E. Burkey is an assistant professor, Phillip S. Miller is a professor, and Roman Moreno and Erin E. Carney are graduate students in the Animal Science Department at the University of Nebraska–Lincoln.

Table 4. Response and significance of dietary DDGS[a] inclusion on final weight and carcass characteristics of growing-finishing pigs without (Treatment 1 and 2) or with (Treatments 3 and 4) previous exposure to DDGS (30%) during the nursery period.

Treatment	1	2	3	4				
	DDGS[a], %							
Nursery	0	0	30	30				
Growing-Finishing	0	30	0	30				
						P-value		
Item					SEM[b]	1[c]	2[d]	3[e]
No. of pigs	5	5	5	5				
Live weight, lb	266.4	245.6	244.6	232.6	10.11	**0.10**	0.12	**0.04**
Carcass Measurements								
Hot carcass weight, lb	204.6	188.0	189.8	179.6	8.34	0.18	0.13	**0.07**
Dressing, %	76.81	76.56	77.51	77.18	0.75	0.39	0.71	0.75
Last rib BF[f], in	0.94	0.98	0.9	1.1	0.11	0.72	0.29	0.68
10^{th}-rib BF, in	0.86	0.84	0.74	0.76	0.07	0.17	0.99	0.33
LMA[g], in^2	11.07	10.6	11.13	10.51	0.54	0.98	0.33	0.61
Ultrasound Measurements								
10^{th}-rib BF, in								
Grower 1 (4 week)	0.42	0.39	0.41	0.4	0.02	0.83	0.28	0.37
Grower 2 (8 week)	0.47	0.51	0.45	0.49	0.02	0.33	0.11	0.70
Finisher 1 (12 week)	0.58	0.59	0.55	0.57	0.04	0.54	0.68	0.81
Finisher 2 (16 week)	0.79	0.78	0.64	0.71	0.05	**0.05**	0.55	0.20
10^{th}-rib LMA, in^2								
Grower 1 (4 week)	2.89	2.81	2.88	2.65	0.17	0.62	0.37	0.56
Grower 2 (8 week)	4.47	4.72	4.34	4.5	0.24	0.48	0.41	0.85
Finisher 1 (12 week)	5.47	5.1	5.41	5.24	0.2	0.83	0.19	0.35
Finisher 2 (16 week)	7.43	6.87	7.26	6.77	0.47	0.77	0.27	0.40

[a]DDGS = Corn dried distillers grains with solubles
[b]SEM = Standard error of the mean
[c]*P*-value: Orthogonal contrast to evaluate the effect of DDGS inclusion in the nursery [(1 + 2) vs. (3 + 4)]
[d]*P*-value: Orthogonal contrast to evaluate the effect of DDGS inclusion in growing-finishing [(1 + 3) vs. (2 + 4)]
[e]*P*-value: Orthogonal contrast to evaluate the effect of DDGS inclusion in the nursery [(1) vs. (2 + 3 + 4)]
[f]BF = Backfat
[g]LMA = Longissimus muscle area