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There was no interaction between lactose and DDGS, but lactose can be incorporated in nursery diet containing DDGS and maintain growth performance.

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Summary

A 4-week feeding experiment was conducted to evaluate effects of distillers dried grains with solubles (DDGS) and lactose on growth performance of nursery pigs. Ninety-six pigs (age, 23 ± 2 days; initial body weight, 14.15 ± 0.11 lb) were randomly allotted into each of 16 pens by gender, ancestry, and weight (6 pigs/pen; 4 pens/treatment). In phase 1 (weeks 1 and 2), pigs were fed 1 of the 4 treatments: A) control (no DDGS and lactose), B) 15% DDGS, C) 20% lactose, D) 15% DDGS + 20% lactose. In phase 2 (weeks 3 and 4), all pigs were fed a common diet containing 15% DDGS and 10% lactose. Diets were formulated to contain 1.47 and 1.42% true ileal digestible Lys in phase 1 and 2, respectively. Pigs receiving DDGS in phase 1 (Treatments B and D) had greater ADG and ADFI (P = 0.05 and 0.004, respectively) during phase 2 compared to non-DDGS fed pigs in phase 1 (Treatment A and C); however, no DDGS effects were observed on ADG, ADFI, and G:F in phase 1. Pigs receiving lactose in Phase 1 (Treatments C and D) had 21% greater ADG, 12% greater G:F (P = 0.01), and a trend of increased ADFI (P = 0.07) during phase 1, but decreased ADG during phase 2 (P = 0.09) compared to pigs that did not receive lactose in phase 1 (Treatments A and B). In conclusion, although there was no interaction between DDGS and lactose in any phase of this experiment, it appeared that lactose can be incorporated in nursery diets containing DDGS and have growth performance maintained.

Introduction

Distillers dried grains with solubles (DDGS) has been included in diets for growing-finishing pigs and sows, but very limited levels for weanling pigs have been used due to

Table 1. Composition of ingredients and calculated analysis, as-fed basis (%).

	Phase 1[a]				Phase 2
Treatment	A	B	C	D	Common diet
DDGS, %	0	15	0	15	15
Lactose, %	0	0	20	20	10
Ingredients, %					
Corn	61.5	47.0	37.0	22.5	36.1
DDGS	0	15	0	15	15
Soybean meal, 46.5% CP	20.5	20.5	20.5	20.5	20.5
Spray-dried porcine plasma	5	5	5	5	2.5
Select menhaden fish meal	6	6	6	6	7.5
DairyLac 80	0	0	25	25	12.5
Dicalcium phosphate, 18.5%P	1.2	0.775	0.4	0	0
Limestone	0.325	0.500	0.450	0.600	0.475
Salt	0.3	0.3	0.3	0.3	0.3
Zinc oxide	0.3	0.3	0.3	0.3	0.3
Vitamin premix[b]	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[c]	0.15	0.15	0.15	0.15	0.15
L-Lysine•HCl	0.285	0.220	0.350	0.285	0.325
DL-Methionine	0.120	0.030	0.185	0.095	0.070
L-Threonine	0.095	0.015	0.138	0.060	0.070
Mecadox 2.5	1	1	1	1	1
Corn oil	3	3	3	3	
Calculated analysis					
CP[d],%	22.8	25.6	21.7	24.4	24.2
Total Lys, %	1.60	1.60	1.60	1.60	1.56
Tid[e] Lys, %	1.47	1.47	1.47	1.47	1.42
Ca, %	0.85	0.85	0.85	0.85	0.82
P, %	0.79	0.78	0.73	0.72	0.69
Available P, %	0.51	0.51	0.51	0.51	0.45
ME[f], kcal[g]/lb	1,531	1,566	1,529	1,564	1,567

[a]Phase 1 diets included: control (A); corn distillers dried grains with soluble (DDGS; B); lactose (C); DDGS plus lactose (D).
[b]Vitamin premix containing: vitamin A as retinyl acetate, 5,500 IU; vitamin D_3 as cholecalciferol, 550 IU; vitamin E as alpha-tocopherol acetate, 30 IU; vitamin K as menadione dimethylpyrimidinol bisulfide, 4.4 mg/kg; niacin, 33 mg/kg, pantothenic acid as d-Calcium pantothenate, 22.05 mg/kg; riboflavin, 11 mg/kg; vitamin B12 as cyanocobalamin, 33 mg/kg.
[c]Trace mineral premix containing: copper (as $CuSO_4•5H_2O$), 10 mg/kg; iodine (as $Ca(IO_3)•H_2O$), 0.25 mg/kg; Iron ($FeSO_4•2H_2O$), 125 mg/kg; manganese (MnO), 15 mg/kg; Selenium (Na_2SeO_3), 0.3 mg/kg; Zinc ($ZnSO_4•H_2O$), 125 mg/kg.
[d]Crude protein.
[e]True ileal digestible.
[f]Metabolizable energy.
[g]kcal=Kilocalories (1,000 cal)

high percentage of insoluble fiber, low starch, and variable amino acid profiles. Publications evaluating effects of feeding DDGS on growth performance of nursery pigs are not numerous and inconsistent results were reported among studies. Some studies have shown that feeding DDGS from 5 to 25% for nursery pigs after 2 or 3 weeks postweaning did not affect weight gain, feed intake, and feed efficiency. In contrast, early introduction of DDGS at high concentration for weanling pigs could decrease average daily gain and feed intake. Because of the expansion of ethanol production concomitant with the increasing DDGS availability, investigating the use of DDGS for nursery pigs is warranted.

Inclusion of dried whey in nursery diets improves growth performance of nursery pigs. It appears that lactose and lacalbumin components in dried whey are responsible for the beneficial effects of dried whey on weanling-pig performance. Also, it has been shown that deproteinized whey can replace the lactose fraction provided by dried whey without affecting growth performance.

The effects of incorporating DDGS with other supplementary ingredients such as milk products on nursery pig performance have received little attention. We hypothesized that supplementation of the lactose fraction of deproteinized whey can compensate for the deficiency of soluble fiber and starch in DDGS diets and consequently improve growth performance of pigs fed DDGS. Therefore, this study was conducted to determine the effects of lactose, DDGS, and their interaction on growth performance of nursery pigs.

Materials and Methods

Animals and Experimental Design

The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee of the University of Nebraska–Lincoln. Ninety-six pigs (48 barrows and 48 gilts) weaned at 23 ± 2 days were randomly allotted in 16 pens by ancestry, initial body weight, and sex (6 pigs/pen). The initial average pig BW was 14.15 ± 0.11 lb. There were four pen replications per treatment with three barrows and three gilts per pen. Pigs were housed in the temperature-controlled room and each pen had a single nipple waterer and a single self-feeder for ad libitum access to water and feed. The study duration was 4 weeks and divided into phase 1 (week 1 to 2) and phase 2 (week 3 to 4).

Dietary Treatments

Dietary treatments were arranged as a 2 × 2 factorial containing the following: A) control (no DDGS and lactose); B) 20% lactose; C) 15% DDGS; and D) 15% DDGS + 20% lactose. The ingredient compositions and calculated analysis of experimental diets are presented in Table 1. Diets in phase 1 and phase 2 were formulated to contain 1.47% and 1.42% true ileal digestible Lys, respectively. Total lysine was 1.60% for all diets in phase 1 and 1.56% for a common diet fed to all treatment groups in phase 2. This common diet was designed to contain 15% DDGS and 10% lactose. Dairylac 80 (International Ingredient Corpora-

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tion, IIC, Mo.), containing 3.2% CP, and 0.06% Lys (analyzed composition) and 80% lactose, was the only source of lactose in this experiment. This product was granular and nonhygroscopic, produced from sweet and dried whey soluble (Cromwell et al. 2008). All amino acids, vitamins, and minerals were formulated to meet or exceed the requirement identified by NRC (1998).

Data and Sample Collection

Individual pig BW and feed disappearance were recorded at the beginning of the experiment and weekly thereafter to calculate average daily gain (ADG), average daily feed intake (ADFI), and ADG:ADFI (G:F ratio).

Statistical Analysis

Growth data were analyzed as a completely randomized design (2 × 2 factorial) using the MIXED procedure of SAS. Each pen was considered an experimental unit. Model included the main effects of DDGS, lactose, and their interaction. Pen was a random effect.

Results and Discussion

Pig BW and growth performance are shown in Table 2. Initial and final BW were 14.15 ± 0.11 and 37.29 ± 0.75 lb, respectively. There was no interaction of DDGS and lactose on pig BW at any phase of this experiment. Except for a lactose effect observed on BW at the end of phase 1 ($P = 0.03$), there was no lactose effect on BW. No DDGS effect was recorded in weeks 1 and 2. However, compared to pigs that did not receive DDGS in phase 1 (week 1 to 2; Treatments A and C), pigs receiving DDGS (Treatments B and D) tended to exhibit increased BW at weeks 3 and 4 ($P = 0.08$ and 0.1, respectively) after being introduced to a common diet containing 15% DDGS and 10% lactose.

There was no interaction between DDGS and lactose on ADG, ADFI, and G:F ratio at any phase of the experiment. However, there were tendencies of lactose to increase ADG at week 1 ($P = 0.1$) and 2 ($P = 0.06$), and a significant lactose effect on G:F ratio ($P = 0.04$) at week 2. During phase 1 (week 1 to 2), ADG and G:F were greater ($P = 0.01$; 21% and 12% greater, respectively) in pigs fed lactose compared to pigs fed no lactose. In addition, pigs fed lactose tended ($P = 0.07$) to have greater ADFI compared to pigs fed no lactose in phase 1. These results are consistent with previous studies that reported feeding lactose during the early phases of the weanling period can increase ADG and G:F. In contrast, DDGS did not affect ADG, ADFI, and G:F in phase 1 (week 1 to 2) of the experiment. Our results agreed with previous studies that showed feeding DDGS immediately after weaning did not affect growth performance and feed efficiency of nursery pigs. However, these results were not consistent with another publication that reported reduced growth performance in pigs introduced to DDGS early in the nursery phase.

There were DDGS effects on ADG and ADFI at week 3 ($P = 0.01$)

Table 2 Effects of feeding DDGS and lactose on growth performance

Treatment[a]	A	B	C	D				
DDGS, %	**0**	**15**	**0**	**15**				
Lactose, %	**0**	**0**	**20**	**20**				
						P- value		
					SEM	P_D[c]	P_L[d]	P_{Dxl}[e]
BW, lb								
Week 0	14.19	14.12	14.17	14.08	0.11	0.49	0.79	0.86
Week 1	16.13	16.15	16.30	16.63	0.20	0.39	0.15	0.54
Week 2	19.62	19.62	20.77	20.75	0.44	1.00	**0.03**	0.98
Week 3	26.97	28.16	27.68	28.36	0.48	**0.08**	0.37	0.60
Week 4	36.30	38.24	37.00	37.62	0.75	**0.10**	0.96	0.38
Phase1 (week 1)								
ADG, lb	0.28	0.29	0.31	0.36	0.03	0.19	**0.10**	0.46
ADFI, lb	0.40	0.42	0.44	0.45	0.02	0.51	0.16	0.80
G:F, lb/lb	0.70	0.69	0.69	0.82	0.04	0.18	0.18	0.15
Phase 1 (week 2)								
ADG, lb	0.50	0.49	0.63	0.59	0.06	0.64	**0.06**	0.74
ADFI, lb	0.76	0.77	0.84	0.82	0.04	0.89	0.21	0.72
G:F, lb/lb	0.65	0.63	0.75	0.71	0.04	0.50	**0.04**	0.86
Phase 2 (week 3)								
ADG, lb	1.05	1.22	0.99	1.09	0.04	**0.01**	**0.05**	0.43
ADFI, lb	1.37	1.51	1.34	1.46	0.04	**0.01**	0.36	0.75
G:F, lb/lb	0.77	0.81	0.74	0.75	0.03	0.45	0.17	0.59
Phase 2 (week 4)								
ADG, lb	1.33	1.44	1.33	1.32	0.06	0.40	0.32	0.34
ADFI, lb	1.98	2.14	1.93	2.07	0.05	**0.02**	0.26	0.86
G:F, lb/lb	0.67	0.67	0.69	0.64	0.02	0.12	0.64	0.15
Phase 1 (week 1, 2)								
ADG, lb	0.39	0.39	0.47	0.48	0.03	0.85	**0.01**	0.98
ADFI, lb	0.58	0.60	0.64	0.63	0.02	0.83	**0.07**	0.64
G:F, lb/lb	0.67	0.65	0.73	0.75	0.03	0.91	**0.01**	0.58
Phase 2 (week 3, 4)								
ADG, lb	1.19	1.33	1.16	1.21	0.04	**0.05**	**0.09**	0.30
ADFI, lb	1.67	1.82	1.63	1.76	0.04	**0.004**	0.22	0.77
G:F, lb/lb	0.71	0.73	0.71	0.68	0.02	0.81	0.21	0.26
Overall (week 1 to 4)								
ADG, lb	0.79	0.86	0.81	0.84	0.02	**0.07**	0.92	0.37
ADFI, lb	1.13	1.21	1.14	1.20	0.03	**0.02**	0.94	0.68
G:F, lb/lb	0.70	0.71	0.72	0.70	0.01	0.84	0.80	0.34

[a]Phase 1 (weeks 1 and 2) dietary treatments included control (A); corn distillers dried grains with soluble (DDGS; B); lactose (C); DDGS plus lactose (D). All pigs were fed a common diet in phase 2 (weeks 3 and 4; 15% DDGS, 10% lactose).
[b]Standard Error of the Mean.
[c]Main effect of DDGS.
[d]Main effect of lactose.
[e]DDGS × lactose interaction.

and ADFI at week 4 ($P = 0.02$). During phase 2 (week 3 to 4), greater ADG ($P = 0.05$) and ADFI ($P = 0.004$) were observed in pigs consuming a diet containing DDGS (Treatments B and D) compared to pigs that did not receive DDGS in phase 1 (Treatments A and C); however, G:F ratio was not affected by DDGS. There was a lactose effect on ADG in week 3 ($P = 0.05$) and a trend of lactose effect on ADG during phase 2 ($P = 0.09$); pigs fed lactose in phase 1 (Treatments C and D) had lower ADG compared to pigs that did not receive lactose in phase 1 (Treatments A and B). These observations reinforced the traditional lactose effects on improving pig growth performance during the early postweaning period. Also, these results indicate that lactose can be added to the DDGS-containing diets and maintain growth performance.

For the overall experimental period (week 1 to 4), greater ADFI ($P = 0.02$) and ADG ($P = 0.07$) were observed in pigs fed DDGS (Treatments B and D) compared to pigs that did not receive DDGS in phase 1 (Treatments A and C); however, no effects of DDGS on G:F ratio. In addition, there were no lactose and lactose × DDGS effects on ADG, ADFI, and G:F overall.

In summary, the following observations were made: 1) pigs receiving DDGS in phase 1 (Treatments B and D) had greater ADG and ADFI ($P = 0.05$ and 0.004, respectively) during phase 2 compared to non-DDGS fed pigs in phase 1 (Treatment A and C); 2) pigs receiving lactose in phase 1 (Treatments C and D) had greater ADG, G:F ($P = 0.01$), and ADFI ($P = 0.07$) during phase 1, but decreased ADG during phase 2 ($P = 0.09$) compared to pigs that did not receive lactose in phase 1 (Treatments A and B).

Conclusions

In conclusion, there was no interaction between DDGS and lactose on growth performance of nursery pigs in any phase of this experiment. However, the inclusion of lactose in diets containing DDGS did have positive effects on improving growth performance of nursery pigs. Additional research needs to be conducted to determine level of lactose that should be incorporated with DDGS in diets to maximize pig performance and health.

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