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SWINE DAY 2023

KANSAS STATE UNIVERSITY SWINE INDUSTRY DAY 2023

Evaluation of Lactose Level Intake and Whey Permeate Form on Nursery Pig Performance[1]

Ethan B. Stas, Jason W. Frank,[2] Tingting Wang,[2] Joel M. DeRouchey, Mike D. Tokach, Jason C. Woodworth, Robert D. Goodband, and Jordan T. Gebhardt[3]

Summary

A total of 1,512 pigs (Line 337 × 1050 PIC; initially 10.4 lb) were used to evaluate lactose level and whey permeate form on nursery pig performance in a commercial environment. Pigs were weaned at approximately 19 d of age and were allotted to 1 of 4 dietary treatments arranged in a 2 × 2 factorial utilizing low or high lactose levels with either granular whey permeate (Dairylac 80, International Ingredients Corporation, Fenton, MO) or spray-dried whey permeate. There were 27 pigs per pen and 14 replications per treatment. Pigs were fed experimental diets in two phases with phase 1 having a 5 lb/pig feed budget and phase 2 having a 12 lb/pig feed budget. The low lactose diets consisted of 10.0 and 4.13% whey permeate for phases 1 and 2, respectively, and targeted a total lactose intake of 0.80 lb/pig. The high lactose diets consisted of 20.0 and 8.25% whey permeate for phases 1 and 2, respectively, and targeted a total lactose intake of 1.60 lb/pig. Following experimental diets, all pigs were fed a common corn-soybean meal-based diet until the completion of the study. There were no lactose level × whey permeate form interactions for the duration of the study ($P > 0.10$). For main effects of lactose level, pigs fed high lactose levels had increased ($P \leq 0.024$) ADFI compared to pigs fed low lactose levels from d 7 to 21 and the experimental period (d 0 to 21). For main effects of whey permeate form, overall (d 0 to 42) pigs fed spray-dried whey permeate had improved ($P = 0.041$) feed efficiency compared to pigs fed granular whey permeate. There were no differences in mortality or removals between treatments ($P > 0.10$). In conclusion, this study suggests a lactose intake of 1.60 lb/pig increases feed intake compared to a lactose intake of 0.80 lb/pig during the experimental period regardless of whey permeate form. Additionally, spray-dried whey permeate improved feed efficiency regardless of the lactose level fed.

[1] Appreciation is expressed to International Ingredients Corporation (Fenton, MO) for partial financial support of this trial and to New Horizon Farms (Pipestone, MN) for use of pigs, facilities, and technical support.

[2] International Ingredients Corporation (Fenton, MO).

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Introduction

Newly weaned pigs undergo a dramatic change in diet composition from a liquid-based diet in the form of sow's milk to a dry cereal-based diet. Therefore, highly palatable, and easily digestible lactose and milk proteins are often added to early nursery diets to ease the diet transition for pigs postweaning. Traditionally, milk coproducts have been used to improve growth performance of nursery pigs, but there are frequent pricing concerns with milk coproducts that may limit their use.

Whey permeate is a coproduct obtained after removing whey proteins and other solids through physical filtration of liquid whey. As a result, whey permeate contains a higher content of lactose than other milk products. Beneficial growth responses and intestinal health of weaned pigs may be attributed to the high lactose concentration in addition to milk oligosaccharides present in whey permeate. The drying methods of whey permeate can vary, but little data are available to determine the impact on piglet performance of spray-dried whey permeate vs. granular whey permeate. Therefore, the objective of this study was to determine if lactose level or form of whey permeate influence nursery pig performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted at a commercial research site owned and operated by New Horizon Farms in Pipestone, MN. Phase 1 diets were manufactured at Hubbard Feeds in Mankato, MN. Phase 2 and 3 diets were manufactured at the New Horizon feed mill located in Pipestone, MN.

Animals and diets

A total of 1,512 pigs (Line 337 × 1050 PIC; initially 10.4 lb) were used in a 42-d study with 27 pigs per pen and 14 replications per treatment. Pigs were weaned at approximately 19 d of age and pens were randomly assigned to treatment based on initial body weight and weaning date. Dietary treatments were arranged in a 2 × 2 factorial with low or high lactose levels provided by either granular whey permeate (Dairylac 80, International Ingredients Corporation, Fenton, MO) or spray-dried whey permeate (Tables 1 and 2). Experimental diets were fed in two phases with phase 1 having a feed budget of 5 lb/pig and phase 2 fed at 12 lb/pig. For phase 1, the high and low lactose levels consisted of 20 and 10% whey permeate, respectively. For phase 2, the high and low lactose levels consisted of 8.25 and 4.13% whey permeate, respectively. This resulted in a total lactose intake of approximately 1.60 and 0.80 lb/pig over the two phases for the high and low lactose levels, respectively. All diets had similar levels of soybean meal within phase. Phase 1 diets were pelleted, and phase 2 diets were fed in meal form. Diets were formulated to contain 1.35% SID Lys and met or exceeded other nutrient requirement estimates established by the NRC.[4] Experimental diets were fed for approximately 21 days post-weaning. Following experimental diets, all pigs were fed a common corn-soybean meal-based diet without lactose until the competition of the study. Pens of pigs were weighed, and feed disappearance was calculated weekly from d 7 to 42 to determine ADG, ADFI, and F/G.

[4] National Research Council. 2012. Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/13298.

Samples of phase 1 diets were collected and analyzed for pellet durability. Pellet durability index (PDI) is measured by placing finished pellets in a tumbler and then calculating the mass of surviving pellets over the total mass of pellets and fines. A high PDI is an indication of more intact pellets and less pellet fines. Samples of phase 2 diets were collected and analyzed for various flowability tests such as angle of repose (AoR), compressibility index, and composite flow index (CFI). Angle of repose is a measure of how steeply a granular material can be piled. It is determined by the angle between the surface of the pile and the height of the pile of material. Compressibility index is a measure of the propensity of a substance to be compressed. It is a ratio of bulk and tapped density. A low AoR and compressibility index is an indication of better flowability. The CFI is an overall measure of flowability based on the results of other tests such as AoR and compressibility. A high CFI indicates better flowability characteristics.

Statistical analysis

Data were analyzed as a randomized complete block design using the RStudio environment (Version 1.3.1093, RStudio, Inc., Boston, MA) using R programming language [Version 4.0.2 (2020-06-22), R Core Team, R Foundation for Statistical Computing, Vienna, Austria] with body weight and weaning date serving as the blocking factor and pen as the experimental unit. Block was included in the model as a random effect. Main effects of lactose level and whey permeate form as well as their interaction were tested using the lmer function. Differences between treatments were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

No in-feed medication was provided to the pigs during any of the feeding phases. However, due to health challenges throughout the study, all pigs were administered water medications at various time points during the study (Table 3).

All four experimental diets had a pellet durability index of 91% or greater, indicating good quality pellets (Table 4). The AoR analysis suggests the high lactose spray-dried whey permeate diet had numerically better flowability and the high lactose granular whey permeate had numerically poorer flowability. However, all angles of repose were within 2.1° of each other, indicating similar flowability across the four diets. The compressibility index suggests the high lactose granular whey permeate diet had numerically better flowability and the low lactose granular whey permeate diet had numerically poorer flowability. The CFI suggests the high lactose granular whey permeate diet had numerically better flowability and the low lactose granular whey permeate had numerically poorer flowability. The compressibility index and CFI indicated that better flowability characteristics were associated with granular whey permeate compared to spray-dried whey permeate when included at higher levels in the diet.

For growth performance (Table 5 and *6*), no lactose × whey permeate form interactions were observed for the duration of the study ($P > 0.10$). For lactose level main effects, there were no significant differences ($P > 0.10$) between low and high lactose levels from d 0 to 7. From d 7 to 21 and the experimental period (d 0 to 21), pigs fed high lactose levels had increased ($P \leq 0.024$) ADFI compared to pigs fed low lactose levels. There were no differences ($P > 0.10$) between pigs previously fed low and high lactose levels during the common period (d 21 to 42) or overall (d 0 to 42) for growth performance or removals and mortalities.

For the main effects of whey permeate form, no significant differences ($P > 0.10$) were observed between pigs fed granular and spray-dried whey permeate from d 0 to 7 or the experimental period (d 0 to 21). From d 7 to 21 and the common period (d 21 to 42), pigs fed spray-dried whey permeate tended to have improved ($P \leq 0.098$) ADG and F/G compared to pigs fed granular whey permeate. Overall (d 0 to 42), pigs fed spray-dried whey permeate tended to have increased ($P = 0.080$) ADG compared to pigs fed granular whey permeate. For overall (d 0 to 42) performance, pigs fed spray-dried whey permeate had improved ($P = 0.041$) F/G compared to pigs fed granular whey permeate. There were no differences ($P > 0.10$) in whey permeate form for removals or mortalities.

In conclusion, pigs fed 1.60 lb of lactose had increased feed intake during the experimental period compared to pigs fed 0.80 lb of lactose, regardless of whey permeate form. However, there were no differences between lactose levels from day 0 to 42. In addition, pigs fed spray-dried whey permeate had improved feed efficiency overall compared to pigs fed granular whey permeate regardless of lactose level. Based on the CFI, the high lactose granular whey permeate diet had numerically better flowability characteristics than the other diets.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Phase 1 diet composition (as-fed basis)[1]

	Low lactose		High lactose	
Item	**Granular whey permeate**	**Spray-dried whey permeate**	**Granular whey permeate**	**Spray-dried whey permeate**
Ingredients, %				
Corn	49.85	49.85	40.23	40.23
Soybean meal, 46.8% CP [2]	23.50	23.50	23.50	23.50
Granular whey permeate[3]	10.00	---	20.00	---
Spray-dried whey permeate	---	10.00	---	20.00
Enzymatically treated soybean meal[4]	7.00	7.00	7.00	7.00
Microbially enhanced soybean meal[5]	2.50	2.50	2.50	2.50
Soybean oil	3.00	3.00	3.00	3.00
Limestone	0.82	0.82	0.78	0.78
Monocalcium phosphate, 21.5% P	1.33	1.33	1.20	1.20
Salt	0.55	0.55	0.30	0.30
L-Lys	0.38	0.38	0.38	0.38
DL-Met	0.22	0.22	0.24	0.24
L-Thr	0.20	0.20	0.20	0.20
L-Trp	0.03	0.03	0.02	0.02
L-Val	0.07	0.07	0.08	0.08
Zinc oxide	0.39	0.39	0.39	0.39
Vitamin premix	0.05	0.05	0.05	0.05
Trace mineral premix	0.08	0.08	0.08	0.08
Inorganic selenium	0.05	0.05	0.05	0.05
Phytase[6]	0.02	0.02	0.02	0.02
Total	100	100	100	100

continued

Table 1. Phase 1 diet composition (as-fed basis)[1]

	Low lactose		High lactose	
Item	Granular whey permeate	Spray-dried whey permeate	Granular whey permeate	Spray-dried whey permeate
SID amino acids, %				
Lys	1.35	1.35	1.35	1.35
Ile:Lys	62	62	61	61
Leu:Lys	120	120	115	115
Met:Lys	37	37	38	38
Met and Cys:Lys	58	58	58	58
Thr:Lys	65	65	65	65
Trp:Lys	20.2	20.2	20.3	20.3
Val:Lys	70	70	70	70
His:Lys	36	36	36	36
Total Lys, %	1.50	1.50	1.49	1.49
NE, kcal/lb	1,185	1,185	1,201	1,201
Calculated CP, %	22.0	22.0	21.5	21.5
Analyzed CP, %[6]	20.3	21.1	20.7	21.3
Ca, %	0.70	0.70	0.69	0.69
P, %	0.68	0.68	0.66	0.66
STTD P, %	0.54	0.54	0.54	0.54
Calculated lactose, %	8.0	8.0	16.0	16.0
Analyzed lactose, %[7]	4.0	6.4	16.7	13.8

[1] Phase 1 diets were provided with a feed budget of 5 lb/pig.
[2] CP = crude protein.
[3] Dairylac 80, International Ingredients Corporation; Fenton, MO.
[4] HP 300; Hamlet Protein; Findlay, OH.
[5] MEPro; Prairie Aquatech, Brooking, SD.
[6] Quantum Blue 5G (ABVista, Plantation, FL) which provided an estimated release of 0.12% STTD P with 341 FTU/lb.
[7] A sample of each diet was submitted to Minnesota Valley Testing Laboratories (New Ulm, MN) for crude protein and lactose content. Samples were analyzed in duplicate and the average of both analyses is reported.

Table 2. Phase 2 diet composition (as-fed basis)[1]

	Low lactose		High lactose	
Item	**Granular whey permeate**	**Spray-dried whey permeate**	**Granular whey permeate**	**Spray-dried whey permeate**
Ingredients, %				
Corn	58.48	58.48	54.55	54.55
Soybean meal, 46.8% CP [2]	25.00	25.00	25.00	25.00
Granular whey permeate[3]	4.13	---	8.25	---
Spray-dried whey permeate	---	4.13	---	8.25
Enzymatically treated soybean meal[4]	7.00	7.00	7.00	7.00
Choice white grease	1.00	1.00	1.00	1.00
Limestone	0.80	0.80	0.78	0.78
Monocalcium phosphate, 21.5% P	1.18	1.18	1.13	1.13
Salt	0.68	0.68	0.55	0.55
Liquid Lys, 55%	0.65	0.65	0.65	0.65
DL-Met	0.22	0.22	0.22	0.22
Thr Pro[5]	0.25	0.25	0.25	0.25
L-Trp	0.04	0.04	0.04	0.04
L-Val	0.10	0.10	0.10	0.10
Zinc oxide	0.25	0.25	0.25	0.25
Vitamin-trace mineral premix	0.20	0.20	0.20	0.20
Phytase[6]	0.05	0.05	0.05	0.05
Total	100	100	100	100

continued

Table 2. Phase 2 diet composition (as-fed basis)[1]

	Low lactose		High lactose	
Item	Granular whey permeate	Spray-dried whey permeate	Granular whey permeate	Spray-dried whey permeate
SID amino acids, %				
Lys	1.35	1.35	1.35	1.35
Ile:Lys	59	59	58	58
Leu:Lys	116	116	115	115
Met:Lys	37	37	37	37
Met and Cys:Lys	58	58	58	58
Thr:Lys	63	63	65	65
Trp:Lys	20.1	20.1	20.2	20.2
Val:Lys	70	70	70	70
His:Lys	37	37	36	36
Total Lys, %	1.49	1.49	1.49	1.49
NE, kcal/lb	1,129	1,129	1,136	1,136
Calculated CP, %	21.6	21.6	21.4	21.4
Analyzed CP, %[7]	20.1	21.0	20.4	20.3
Ca, %	0.68	0.68	0.67	0.67
P, %	0.65	0.65	0.65	0.65
STTD P, %	0.52	0.52	0.52	0.52
Calculated lactose, %	3.3	3.3	6.6	6.6
Analyzed lactose, %[7]	2.6	2.2	5.9	4.6

[1] Phase 2 diets were provided with a feed budget of 12 lb/pig.
[2] CP = crude protein.
[3] Dairylac 80; International Ingredients Corporation, Fenton, MO.
[4] HP 300; Hamlet Protein; Findlay, OH.
[5] CJ America; Los Angeles, CA.
[6] Optiphos Plus 2500 G (Huvepharma Inc.; Peachtree City, GA) which provided an estimated release of 0.13% STTD P with 567 FTU/lb.
[7] A sample of each diet was submitted to Minnesota Valley Testing Laboratories (New Ulm, MN) for crude protein and lactose content. Samples were analyzed in duplicate and the average of both analyses is reported.

Table 3. Water medication administration[1]

Medication administered	Days of administration	Amount administered/pig
Escherichia coli vaccine	0	1 mL
Buffered electrolytes[2]	0 to 10	0.30 oz
Amoxicillin[3]	3 to 10	0.40 g
Gentamicin[4]	3 to 10	0.24 g
Penicillin[5]	11 to 28	0.07 oz
Aspirin[6]	11 to 35	0.21 oz

[1] Water medications were administered to all pigs.
[2] Sky-Lytes; Skylar Nutrition; Rushville, IL.
[3] Veterinary Pharmaceutical Solutions; St. Peter, MN.
[4] Gen-Gard; Huvepharma; Peachtree City, GA.
[5] R-Pen; Huvepharma; Peachtree City, GA.
[6] Oral-Pro; Aurora Pharmaceutical; Northfield, MN.

Table 4. Experimental diet quality characteristics[1]

	Low lactose		High lactose	
Item	Granular whey permeate	Spray-dried whey permeate	Granular whey permeate	Spray-dried whey permeate
Phase 1[2]				
Pellet durability index, %	91.3 ± 0.00	92.7 ± 0.01	95.0 ± 0.00	92.5 ± 0.00
Phase 2				
Angle of repose, °	38.7	39.5	40.2	38.1
Compressibility index, %	23.5	19.7	19.0	22.1
Composite flow index	56.3	58.3	60.5	57.6

[1] Phase 1 diets were analyzed for pellet durability index. Phase 2 diets were analyzed for flowability characteristics such as angle of repose (AoR), compressibility index, and a composite flow index. Composite flow index is a flowability measure determined by utilizing the results of various other flowability procedures such as AoR and compressibility index.
[2] Sample was analyzed in duplicate, therefore, the standard deviation of the two analyses is reported.

Table 5. Interactive effects of lactose level and whey permeate form on nursery pig performance[1]

	Low lactose		High lactose			*P* =		
Item	Granular whey permeate[2]	Spray-dried whey permeate	Granular whey permeate[2]	Spray-dried whey permeate	SEM	Lactose × Form	Lactose level	Whey permeate form
BW, lb								
d 0	10.4	10.4	10.4	10.4	0.38	0.981	0.907	0.963
d 7	10.7	10.7	10.7	10.7	0.41	0.895	0.903	0.890
d 14	13.3	13.4	13.5	13.5	0.54	0.891	0.526	0.921
d 21	17.6	17.9	17.8	18.1	0.70	0.795	0.435	0.237
d 42	33.2	34.1	33.3	34.0	1.13	0.810	0.947	0.145
d 42 per pig placed[3]	25.2	26.8	26.1	27.0	1.48	0.709	0.578	0.208
Day 0 to 7								
ADG, lb	0.03	0.04	0.04	0.04	0.015	0.622	0.673	0.789
ADFI, lb	0.28	0.29	0.30	0.29	0.011	0.306	0.230	0.823
G:F	0.11	0.13	0.13	0.11	0.050	0.569	0.974	0.884
F/G[4]	8.77	7.94	7.63	9.01	---	0.569	0.974	0.884
Day 7 to 21								
ADG, lb	0.47	0.48	0.47	0.50	0.025	0.480	0.304	0.079
ADFI, lb	0.65	0.67	0.69	0.68	0.019	0.299	0.024	0.506
G:F	0.71	0.72	0.68	0.73	0.025	0.155	0.511	0.087
F/G[4]	1.41	1.40	1.47	1.38	---	0.155	0.511	0.087
Day 0 to 21[5]								
ADG, lb	0.30	0.31	0.31	0.33	0.020	0.742	0.348	0.228
ADFI, lb	0.51	0.53	0.54	0.54	0.014	0.183	0.010	0.489
G:F	0.59	0.59	0.56	0.60	0.028	0.408	0.726	0.205
F/G[4]	1.71	1.69	1.77	1.66	---	0.408	0.726	0.205
Day 21 to 42								
ADG, lb	0.70	0.75	0.71	0.73	0.027	0.511	0.765	0.087
ADFI, lb	1.09	1.13	1.11	1.13	0.038	0.600	0.736	0.257
G:F	0.65	0.66	0.64	0.65	0.009	0.767	0.177	0.098
F/G[4]	1.55	1.51	1.57	1.54	---	0.767	0.177	0.098

continued

Table 5. Interactive effects of lactose level and whey permeate form on nursery pig performance[1]

	Low lactose		High lactose			*P* =		
Item	Granular whey permeate[2]	Spray-dried whey permeate	Granular whey permeate[2]	Spray-dried whey permeate	SEM	Lactose × Form	Lactose level	Whey permeate form
Day 0 to 42 (overall)								
ADG, lb	0.49	0.52	0.50	0.52	0.023	0.689	0.739	0.080
ADFI, lb	0.78	0.81	0.81	0.82	0.025	0.384	0.251	0.220
G:F	0.62	0.64	0.61	0.63	0.013	0.855	0.400	0.041
F/G[4]	1.62	1.57	1.64	1.59	---	0.855	0.400	0.041
Day 0 to 42 (overall) per pig placed								
ADG, lb	0.37	0.41	0.39	0.41	0.037	0.695	0.553	0.187
ADFI, lb	0.65	0.68	0.72	0.69	0.034	0.308	0.143	0.982
G:F	0.55	0.61	0.53	0.60	0.052	0.810	0.502	0.037
F/G[4]	1.81	1.63	1.90	1.67	---	0.810	0.502	0.037
Day 0 to 42 (overall)								
Removals, %[8]	19.0	18.0	17.5	17.5	3.28	0.872	0.748	0.872
Mortality, %[9]	6.9	4.0	5.8	4.2	2.86	0.818	0.890	0.435
Total mortality, %[10]	13.8	11.4	12.4	9.3	2.85	0.890	0.549	0.334
Total removals and mortality, %	25.9	22.0	23.5	21.7	3.06	0.731	0.668	0.346

[1] A total of 1,512 pigs (initial BW of 10.4 ± 0.38 lb) were used in a 42-d nursery trial. A total of 4 dietary treatments were arranged in a 2 × 2 factorial consisting of low or high lactose levels of the diet with either granular whey permeate or spray-dried whey permeate. There were 27 pigs per pen and 14 replications per treatment. Experimental diets were fed in 2 phases for approximately 21 d and targeted a lactose intake of 0.80 and 1.60 lb/pig for the low and high lactose treatments, respectively. Pigs received a feed budget of 5 and 12 lb/pig for phases 1 and 2, respectively. Following phase 2, all pigs were fed a common diet for the remainder of the trial.

[2] Dairylac 80, International Ingredients Corporation, Fenton, MO.

[3] BW per pig placed = final ending weight ÷ pigs placed.

[4] F/G was calculated from G:F by taking the inverse, therefore the *P* values are the same and there are no reported SEM.

[5] Approximate feeding period of experimental diets.

[6] ADG per pig placed = (final ending weight – initial weight) ÷ (pigs initially placed × days of trial).

[7] ADFI per pig placed = (total feed intake) ÷ (pigs initially placed × days of trial).

[8] Percentage of pigs that were removed into a hospital pen.

[9] Percentage of pigs that died/euthanized in original pen.

[10] Percentage of pigs that died/euthanized in original pen or hospital pen after being removed.

Table 6. Main effects of lactose level and whey permeate form on nursery pig performance[1]

Item	Low lactose[2]	High lactose[3]	SEM	*P* =	Granular whey permeate[4]	Spray-dried whey permeate	SEM	*P* =
BW, lb								
d 0	10.4	10.4	0.37	0.907	10.4	10.4	0.37	0.963
d 7	10.7	10.7	0.40	0.903	10.7	10.7	0.40	0.890
d 14	13.4	13.5	0.52	0.526	13.4	13.4	0.52	0.921
d 21	17.8	18.0	0.68	0.435	17.7	18.0	0.68	0.237
d 42	33.6	33.7	1.07	0.947	33.3	34.0	1.07	0.145
d 42 per pig placed[5]	26.0	26.6	1.32	0.578	25.7	26.9	1.32	0.208
Day 0 to 7								
ADG, lb	0.04	0.04	0.013	0.673	0.04	0.04	0.013	0.789
ADFI, lb	0.29	0.30	0.010	0.229	0.29	0.29	0.010	0.823
G:F	0.12	0.12	0.046	0.974	0.12	0.12	0.046	0.884
F/G[6]	8.33	8.26	---	0.974	8.13	8.40	---	0.884
Day 7 to 21								
ADG, lb	0.47	0.48	0.023	0.304	0.47	0.49	0.023	0.079
ADFI, lb	0.66	0.69	0.017	0.024	0.67	0.68	0.017	0.506
G:F	0.71	0.70	0.022	0.511	0.70	0.72	0.022	0.087
F/G[6]	1.40	1.42	---	0.511	1.44	1.39	---	0.087
Day 0 to 21[7]								
ADG, lb	0.31	0.32	0.019	0.348	0.31	0.32	0.019	0.228
ADFI, lb	0.52	0.54	0.013	0.010	0.53	0.53	0.013	0.489
G:F	0.59	0.58	0.025	0.726	0.57	0.60	0.025	0.205
F/G[6]	1.70	1.72	---	0.726	1.74	1.68	---	0.205
Day 21 to 42								
ADG, lb	0.72	0.72	0.024	0.765	0.71	0.74	0.024	0.087
ADFI, lb	1.11	1.12	0.034	0.736	1.10	1.13	0.024	0.257
G:F	0.65	0.64	0.007	0.177	0.64	0.65	0.007	0.097
F/G[6]	1.53	1.56	---	0.177	1.56	1.53	---	0.097

continued

Table 6. Main effects of lactose level and whey permeate form on nursery pig performance[1]

Item	Low lactose[2]	High lactose[3]	SEM	*P* =	Granular whey permeate[4]	Spray-dried whey permeate	SEM	*P* =
Day 0 to 42 (overall)								
ADG, lb	0.50	0.51	0.021	0.739	0.49	0.52	0.021	0.080
ADFI, lb	0.80	0.81	0.022	0.251	0.79	0.81	0.022	0.220
G:F	0.63	0.62	0.011	0.400	0.61	0.63	0.011	0.041
F/G[6]	1.59	1.62	---	0.400	1.63	1.58	---	0.041
Day 0 to 42 (overall) per pig placed								
ADG, lb	0.39	0.40	0.034	0.553	0.38	0.41	0.034	0.187
ADFI, lb	0.66	0.70	0.028	0.143	0.68	0.68	0.028	0.982
G:F	0.58	0.56	0.047	0.502	0.54	0.61	0.047	0.037
F/G[6]	1.72	1.78	---	0.502	1.85	1.65	---	0.037
Day 0 to 42 (overall)								
Removals, %[10]	18.5	17.5	2.32	0.748	18.3	17.7	2.32	0.872
Mortality, %[11]	5.4	5.0	2.02	0.890	6.3	4.1	2.02	0.435
Total mortality, %[12]	12.6	10.8	2.01	0.549	13.1	10.3	2.01	0.334
Total removals and mortality, %	23.9	22.6	2.17	0.668	24.7	21.8	2.17	0.346

[1] A total of 1,512 pigs (initial BW of 10.4 ± 0.38 lb) were used in a 42-d nursery trial. A total of 4 dietary treatments were arranged in a 2 × 2 factorial consisting of low or high lactose levels of the diet with either granular whey permeate or spray-dried whey permeate. There were 27 pigs per pen and 14 replications per treatment. Experimental diets were fed in 2 phases for approximately 21 d. Pigs received a feed budget of 5 and 12 lb/pig for phases 1 and 2, respectively. Following phase 2, all pigs were fed a common diet for the remainder of the trial.

[2] Targeted a total lactose intake of 0.80 lb/pig.

[3] Targeted a total lactose intake of 1.60 lb/pig.

[4] Dairylac 80, International Ingredients Corporation, Fenton, MO.

[5] BW per pig placed = final ending weight ÷ pigs placed.

[6] F/G was calculated from G:F by taking the inverse, therefore the *P*-values are the same and there are no reported SEM.

[7] Approximate feeding period of experimental diets.

[8] ADG per pig placed = (final ending weight – initial weight) ÷ (pigs initially placed × days of trial).

[9] ADFI per pig placed = (total feed intake) ÷ (pigs initially placed × days of trial).

[10] Percentage of pigs that were removed into a hospital pen.

[11] Percentage of pigs that died/euthanized in original pen.

[12] Percentage of pigs that died/euthanized in original pen or hospital pen after being removed.