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Assessment of lactose level in the mid- to late-nursery phase on performance of weanling pigs[1,2]

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ABSTRACT: An experiment involving a total of 1,320 crossbred pigs was conducted at 3 universities to assess the effects of various levels of lactose in diets during phase 3 (wk 3 and 4 postweaning) of a 4-phase starter program. Pigs were weaned at 15 to 20 d (6.2-kg initial BW) and allotted to 5 treatments. All pigs were fed a complex phase 1 diet (20% lactose) the first week postweaning followed by a complex phase 2 diet (15% lactose) the second week postweaning. Phase 3 diets containing 0, 2.5, 5.0, 7.5, or 10.0% lactose were fed for wk 3 and 4, and then a common, corn-soybean meal diet was fed for an additional 1 to 2 wk (phase 4). The source of lactose was Dairylac 80, which contains 80% lactose. The phase 1, 2, and 3 diets were prepared at one site. Pigs were weighed, and feed intake was determined at weekly intervals. There were 8 replications at each station for a total of 24 replications per treatment with 5 or 23 pigs per pen. As expected, ADG, ADFI, and G:F were not affected (P = 0.10) during the initial 2-wk period when all pigs received the same diet. During wk 3 and 4 (phase 3) when the 5 levels of lactose were fed, ADG and ADFI increased linearly (P < 0.01) with increasing levels of lactose, but G:F was not affected (P = 0.10). Although the quadratic component was not significant, ADG and ADFI reached a numerical plateau at the 7.5% inclusion level of lactose during phase 3. Compared with pigs fed the diet without lactose, the 7.5% level of lactose resulted in 350 g of additional BW gain coupled with 420 g of additional feed consumed per pig during phase 3, and most of the additional BW gain (294 g) was maintained through the end of the 5- to 6-wk study. These results suggest that pigs respond to dietary lactose during the mid to latter phase of the nursery period and that the response was obtained under different management and facility conditions.

Key words: lactose, pig, weaning

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INTRODUCTION

Dried whey has been used in postweaning pig diets for several decades to provide a highly digestible source of nutrients. Inclusion levels during its early use were generally low (<5% of the diet) because of the occurrence of diarrhea (Krider et al., 1949). Improvements in processing and drying technology of liquid whey have produced a high-quality product that greatly enhances pig performance responses (Mahan, 1984). Improved pig performance has been demonstrated at dietary levels up to 35% (Graham et al., 1981; Mahan et al., 1981; Tokach et al., 1989).

The nutritional value of whey resides somewhat in its high-quality protein fraction (Tokach et al., 1989; Mahan, 1992), but its carbohydrate fraction (lactose) is responsible for most of the response in growth rate and feed intake (Baird et al., 1974; Mahan, 1992). Lactose also has been shown to help maintain an enhanced intestinal environment in pigs (Wolter et al., 2003).

Numerous studies have shown that growth rate and feed intake of early-weaned pigs are improved when either dried whey or crystalline lactose is included in the diet (Graham et al., 1981; Tokach et al., 1989; Mahan, 1993; Nessmith et al., 1997a,b). Recent studies by Mahan et al. (2004) indicated that although positive responses to increasing dietary lactose levels occurred during the postweaning period, the responses declined

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[2]Appreciation is extended to International Ingredient Corporation (St. Louis, MO) for providing Dairylac 80 as the source of lactose in this study, to R. M. Trotter and K. M. Halpin (International Ingredient Corporation) for assistance in designing the study, and to V. R. Barnett, University of Kentucky, for assistance in summarizing and analyzing the data.

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Table 1. Numbers, ages, and BW of pigs from each station

	Station[1]		
Item	KY	OH	MO
Replications, n	8	8	8
Pigs/pen, n	5	5	23
Pigs/treatment, n	40	40	184
Total pigs, n	200	200	920
Initial age, d	19.0	18.0	17.5
Initial BW, kg	6.83	5.85	5.92
Final BW, kg	25.69	26.36	23.85
Floor space/pig, m^2	0.28	0.30	0.17

[1]KY = University of Kentucky; OH = The Ohio State University; and MO = University of Missouri.

as postweaning age advanced. This study was conducted at 3 research stations to evaluate dietary levels of lactose during the period from 2 to 4 wk postweaning (phase 3) of a 4-phase starter program for weanling pigs and to determine if the response to lactose was maintained after its elimination from the diet during the final 1 to 2-wk period.

MATERIALS AND METHODS

An experiment involving a total of 1,320 crossbred pigs was conducted at the University of Kentucky, Lexington (**KY**); The Ohio State University, Columbus (**OH**); and the University of Missouri, Columbia (**MO**), to assess the effects of various lactose levels in the starter diet during phase 3 of a 4-phase starter program for early weaned pigs. Experiments were conducted using similar protocols and following the animal care and use guidelines of each university.

Pigs were weaned at 15 to 20 d (6.2-kg average initial BW) and allotted to 5 dietary treatments from outcome groups based on BW and sex. At the KY and OH stations, pigs were from the university herd. They initially averaged 19 and 18 d of age with average BW of 6.83 and 5.83 kg, respectively (Table 1). Pigs at the MO station were transported from a commercial sow unit (approximately a 3-h trip after weaning) to a commercial nursery designed for research, where the experiment was conducted. The pigs at MO averaged 17.5 d of age and 5.92 kg of BW at the beginning of the experiment. Pigs were penned in groups of 5 at the KY and OH stations and in groups of 23 at the MO station. Pigs were penned by sex at MO, whereas sexes were mixed in pens at KY and OH. Sex ratio within replication was constant at the KY station but not at the OH station. There were 8 replications per treatment at each station for a total of 24 replications per treatment in the study.

Temperature-controlled, slotted-floor nursery buildings were used at each station. Pens were 1.52 × 2.54 m at the MO station and 1.22 × 1.22 m at the other 2 stations. The nursery facility at the KY station was relatively new, whereas those at the OH and MO stations had been in use for several years. The facilities at each station were cleaned and disinfected before placing the pigs in the pens. Each pen was equipped with a nursery-type self-feeder and nipple waterer. Diets and water were available on an ad libitum basis. Pigs were weighed, and feed intake was determined at weekly intervals.

The study consisted of 4 phases. Phases 1 and 2 were each 1 wk in length, phase 3 was 2 wk, and phase 4 ranged from 1 (KY) to 2 (MO) wk in length. At OH, phase 4 averaged 12.5 d in length. Average pig BW at the end of phases 1 to 4 were 7.47, 10.29, 17.90, and 25.30 kg, respectively.

Dietary Treatments

Composition of the diets is shown in Table 2. All pigs received the same diet during the first 2 phases of the study. The phase 1 and 2 diets consisted of corn, soybean meal, dried animal plasma, dried whey, lactose (Dairylac 80, International Ingredient Corp, St. Louis, MO), menhaden fish meal, fat, and crystalline Lys, Thr, and Met. The phase 1 and 2 diets were calculated to contain 20.0 and 15.0% lactose, respectively, and 1.60% total Lys.

Five dietary levels of lactose (0, 2.5, 5.0, 7.5, and 10.0%) were evaluated during phase 3 of the study. These diets were formulated to contain 1.56% total Lys and 1.42% true ileal digestible Lys. In the phase 3 diets, Dairylac 80 was also the source of lactose and was substituted for an equal amount of corn. Levels of dicalcium phosphate, ground limestone, and salt were adjusted to maintain constant dietary levels of Ca, P, and Na. Levels of supplemental Lys, Thr, and Met were adjusted to maintain similar levels of total Lys, Thr, and Met + Cys within the 5 diets of each phase. During phase 4, a common diet (mainly corn and soybean meal with added AA but with no lactose) was fed to all treatment groups. This diet was calculated to contain 1.44% total Lys.

The diets in all phases were formulated to meet or exceed the NRC (1998) requirements for AA, minerals, and vitamins. Carbadox was included in all diets at 55 mg/kg. In addition, Zn oxide and Cu sulfate were included in phase 1 and 2 diets at pharmacologic levels (2,150 mg/kg Zn and 125 mg/kg Cu), and Cu was included at 250 mg/kg in the phase 3 and 4 diets.

Phase 1 and 2 diets were pelleted and rolled to form crumbles, whereas phase 3 and 4 diets were in meal form. Phase 1, 2, and 3 diets were prepared at the MO station and shipped to the other 2 stations. Each station prepared phase 4 diets in their university feed mixing facilities using their own feed ingredients.

A single source of Dairylac 80 (a granular, nonhygroscopic product produced from sweet, dried whey solubles) was used as the source of lactose in the experimental diets. It contained (as analyzed) 96% DM, 79.3% lactose, 4.6% CP, 0.46% fat, 0.12% crude fiber, and 9.84% ash. Although not analyzed for AA or minerals,

Table 2. Composition of the diets (% as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3, lactose, %					Phase 4
			0	2.5	5.0	7.5	10.0	
Corn, ground	37.58	41.99	57.11	54.07	51.03	47.98	44.93	56.91
Soybean meal, 48% CP	18.00	22.00	30.00	30.00	30.00	30.00	30.00	35.00
Dried whey[2]	20.00	10.00	—	—	—	—	—	—
Dairylac 80[3]	7.50	10.00	—	3.13	6.25	9.38	12.50	—
Menhaden fish meal, select	6.00	7.50	6.00	6.00	6.00	6.00	6.00	—
Spray-dried animal plasma[4]	5.00	2.50	—	—	—	—	—	—
Choice white grease	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Dicalcium phosphate	—	—	0.90	0.80	0.69	0.59	0.48	1.80
Limestone, ground	0.55	0.46	0.45	0.47	0.49	0.51	0.53	0.70
Salt	0.30	0.30	0.43	0.41	0.40	0.39	0.38	0.50
L-Lys·HCl, 78%	0.15	0.23	0.27	0.28	0.28	0.28	0.29	0.30
L-Thr	0.03	0.10	0.17	0.17	0.18	0.18	0.19	0.13
DL-Met	0.14	0.17	0.17	0.17	0.18	0.19	0.20	0.16
Vitamin premix[5]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[6]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Antimicrobial agent[7]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Zinc oxide[8]	0.30	0.30	—	—	—	—	—	—
Copper sulfate[9]	0.05	0.05	0.10	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[1]KY = University of Kentucky; OH = The Ohio State University; MO = University of Missouri. A common diet mixed at the MO station was fed during phase 1 (wk 1) and phase 2 (wk 2) of the study. The experimental diets, mixed at the MO station, were fed during phase 3 (wk 3 and 4) of the experiment. A common diet mixed at each station was fed during phase 4 [wk 5 (KY) or wk 5 and 6 (OH and MO)].
[2]Roller-dried whey (International Ingredient Corp., St. Louis, MO).
[3]Calculated to contain 80% lactose, 0.15% Lys, 0.52% Ca, 0.63% P, and 3.0% NaCl (International Ingredient Corp.).
[4]Spray-dried animal plasma (AP-920, APC Co., Ankeny, IA).
[5]Provided per kilogram of diet: vitamin A, 11,600 IU; vitamin D_3, 1,100 IU; vitamin E, 22 IU; vitamin K (as menadione sodium bisulfite complex), 4 mg; riboflavin, 8.25 mg; D-pantothenic acid, 28 mg; niacin, 33 mg; and vitamin B_{12}, 0.03 mg.
[6]Provided per kilogram of diet: Zn, 165 mg (Zn sulfate); Fe, 165 mg (Fe sulfate); Mn, 33 mg (Mn sulfate); Cu, 16.5 mg (Cu sulfate); I, 0.3 mg (ethylenediamine dihydriodide); and Se, 0.3 mg (Na selenite).
[7]Mecadox, provided 55 mg/kg of carbadox.
[8]Contained 72% Zn, which provided 2,150 mg/kg of Zn in phase 1 and 2 diets.
[9]Provided 125 mg/kg of Cu in phase 1 and 2 diets and 250 mg/kg of Cu in phase 3 and 4 diets.

it typically contains 0.15% Lys, 0.52% Ca, 0.63% P, and 3.0% NaCl (product sheet, International Ingredient Corp.).

Chemical Analyses

The Dairylac 80 and representative samples of the diets were analyzed for lactose by method 980.13 of the AOAC (1995). In addition, the diets were analyzed for DM, CP, crude fat, crude fiber, and ash using standard analytical procedures (AOAC, 1995). Lysine was analyzed with ion exchange chromatography after acid hydrolysis with 6 *N* HCl for 24 h at 110°C (AOAC, 1995). The Lys assays were performed at the University of Missouri Experiment Station Chemical Laboratories (Columbia), and the other assays were conducted at O'Neal Scientific Services (St. Louis, MO).

Statistical Analyses

The data were analyzed as a randomized complete block design (Steel and Torrie, 1980) using the GLM procedure (SAS Inst. Inc., Cary, NC). The statistical model included the effects of station, replication within station, treatment, station × treatment, and replication within station × treatment. Station effects were tested with replication within station (21 df), whereas treatment effects and the station × treatment interaction were tested with the replication within station × treatment term (84 df). Orthogonal polynomial coefficients were used to partition treatments into linear, quadratic, cubic, and quartic effects. In all instances, pen was considered the experimental unit. Unless stated otherwise, an α level of $P < 0.05$ was considered statistically significant.

RESULTS

The analyzed lactose levels of the 5 experimental diets were close to calculated levels as shown in Table 3. The other nutrients analyzed approximated the targeted levels except for CP and Lys contents of the phase 4 diets, which were lower than calculated; however, the Lys level of the phase 4 diets still exceeded NRC (1998) requirements.

The overall results of the study for the 3 stations are presented in Table 4. In all instances, ADG and ADFI differed ($P < 0.01$) among the 3 stations, and in most

Table 3. Calculated and analyzed composition of the diets (as-fed basis)

Item	Phase 1	Phase 2	Phase 3 (lactose, %) 0	2.5	5.0	7.5	10.0	Phase 4
Calculated analysis[1]								
Lactose, %	20.0	15.0	0.0	2.5	5.0	7.5	10.0	0.0
CP, %	22.5	22.7	23.2	23.1	23.0	22.9	22.9	21.8
Lys, %	1.60	1.60	1.56	1.56	1.56	1.56	1.56	1.44
Thr, %	1.02	1.03	1.04	1.04	1.04	1.04	1.04	0.94
Trp, %	0.29	0.27	0.27	0.27	0.27	0.27	0.27	0.26
Met + Cys, %	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.86
Ca, %	0.79	0.78	0.80	0.80	0.80	0.80	0.80	0.80
P, %	0.72	0.71	0.72	0.71	0.70	0.69	0.68	0.73
Bioavailable P, %	0.47	0.43	0.40	0.40	0.40	0.40	0.40	0.40
ME, Mcal/kg	3.40	3.42	3.43	3.43	3.43	3.43	3.43	3.37
Determined analysis								
DM, %	91.5	91.3	88.3	88.7	89.2	89.6	89.7	87.9
Lactose, %	20.00	15.41	ND[2]	2.44	4.57	7.27	9.90	ND
CP, %	22.4	21.9	22.8	22.4	21.7	21.5	22.6	17.2
Lys, %	1.47	1.58	1.52	1.59	1.53	1.50	1.54	1.28
Fat, %	5.4	5.6	5.2	5.1	5.3	5.9	5.4	5.1
Crude fiber, %	2.2	2.3	2.9	2.8	2.7	2.7	2.5	2.9
Ash, %	7.5	7.6	6.3	6.8	6.8	7.3	7.0	4.9

[1]Based on the NRC (1998) for all ingredients except Dairylac-80 (International Ingredient Corp., St. Louis, MO), which was calculated to contain 80% lactose, 0.15% Lys, 0.52% Ca, and 0.63% P.

[2]ND = not detected. The limit of detection of lactose was 0.5%.

cases, so did G:F. There was no station × treatment interaction for ADG or ADFI during any of the test periods. For G:F, there tended to be an interaction between station and treatment when phases 1 and 2 were combined ($P < 0.08$) and when phases 1, 2, and 3 were combined ($P < 0.06$); however, there was no station × treatment interaction for G:F during phase 3 when the treatments were imposed or during any of the other phases.

As expected, pig performance was not affected ($P = 0.10$) during the initial 2-wk experimental period (phase 1 and phase 2) when all pigs received a common diet (Table 4). During the 2-wk period of phase 3 when the 5 levels of lactose were fed, both ADG and ADFI increased linearly ($P < 0.01$) with increasing levels of lactose, but G:F was not affected ($P = 0.10$). Although the quadratic component was not significant, ADG and ADFI of the pooled results of the 3 stations reached a numerical plateau at the 7.5% level of lactose inclusion during phase 3.

During phase 4, when all pigs received a common diet, pigs that had previously consumed the phase 3 diet containing 10% lactose gained slower than pigs in the other treatment groups. Overall, the response to lactose level was linear ($P < 0.05$); however, most of the decline in growth rate during phase 4 compared with the control treatment group occurred in pigs previously fed the highest (10%) level of lactose. Feed intake and G:F during phase 4 varied slightly, but the differences among treatments were not significant ($P = 0.10$). Over the entire 5 to 6-wk study, ADG and ADFI were numerically greatest in pigs that had been fed the 7.5% level of lactose during phase 3; however, the difference among treatments over the 5 to 6-wk study was not significant ($P = 0.10$).

DISCUSSION

Dried whey, a by-product of the cheese industry, has commonly been used in pig starter diets for many years. Numerous studies have clearly shown that dried whey results in increased feed intake and growth rate in early weaned pigs (Graham et al., 1981; Tokach et al., 1989; Nessmith et al., 1997a,b), especially when added at relatively high levels in the diet (Mahan, 1992; Mahan et al., 2004). The nutritional benefits of whey reside somewhat in its high-quality protein fraction (Tokach et al., 1989; Mahan, 1992), which consists primarily of β-lactoglobulin, α-lactoalbumin, BSA, and immunoglobulin, along with smaller amounts of lactoferrin, lactoperoxidase, lysozyme, casein glycomacropeptide, phosphopeptides, and fat globule membrane proteins (Harper, 2000). However, the carbohydrate fraction of whey (lactose) is the factor responsible for providing most of the response in growth rate and feed intake (Baird et al., 1974; Mahan, 1992).

Lactose not only can serve as an energy source for the weanling pig, but it evidently contributes other attributes. Our results indicate that feed intake in weanling pigs was enhanced by the inclusion of lactose to the diet, thus reflecting a stimulation of appetite. Greater feed intakes to lactose inclusion have been reported by others (Graham et al., 1981; Tokach et al., 1989; Mahan, 1993; Nessmith et al., 1997ab), but our experiment differs in that we evaluated various levels of lactose during the middle to late part of the starter

Table 4. Summary of the results[1]

Item	Station			Lactose in phase 3 diets, %					CV
	KY	OH	MO	0	2.5	5.0	7.5	10.0	
Pens, n	40	40	40	24	24	24	24	24	
Pigs, n	200	200	920	264	264	264	264	264	
BW, kg									
Initial[2]	6.83	5.85	5.92	6.20	6.15	6.22	6.23	6.20	3.04
wk 1[3] (end of phase 1)	8.67	6.83	6.92	7.51	7.39	7.45	7.52	7.50	3.94
wk 2[3] (end of phase 2)	11.78	10.05	9.04	10.38	10.25	10.21	10.27	10.33	4.12
wk 4[3,4] (end of phase 3)	20.60	17.83	15.28	17.73	17.71	17.87	18.07	18.14	3.96
Final[2] (end of phase 4)	25.69	26.36	23.85	25.20	25.13	25.28	25.49	25.37	3.52
Phase 1 (wk 1; common diet)									
ADG,[3] g	262	150	140	189	179	178	187	184	16.67
ADFI,[3] g	295	217	168	228	219	224	236	227	14.29
G:F,[3] g/kg	890	694	834	832	805	790	796	807	12.91
Phase 2 (wk 2; common diet)									
ADG,[3] g	444	423	301	387	397	384	383	396	10.26
ADFI,[3] g	561	469	381	473	465	461	478	474	10.37
G:F,[3,5] g/kg	796	906	793	816	859	832	814	835	8.53
Phase 3 (wk 3)									
ADG,[3,4] g	561	490	417	467	467	503	505	506	8.94
ADFI,[3,4] g	700	649	551	613	618	643	646	648	8.16
G:F, g/kg	797	757	757	759	756	782	776	780	6.70
Phase 3 (wk 4)									
ADG,[3] g	700	629	476	597	600	592	610	610	7.00
ADFI,[3,6] g	994	896	634	833	830	826	860	856	6.28
G:F,[2] g/kg	706	707	749	723	727	720	716	718	6.74
Phase 3 (wk 3 and 4)									
ADG,[3,4] g	631	560	446	532	534	547	557	558	5.08
ADFI,[3,4] g	847	772	592	723	724	735	753	752	6.19
G:F, g/kg	745	728	753	738	739	747	742	745	4.46
Phases 1, 2, and 3 (wk 1 to 4)									
ADG,[3,6] g	492	423	333	410	411	414	421	424	5.58
ADFI,[3,6] g	637	558	433	537	533	539	555	551	6.19
G:F,[2] g/kg	772	744	777	769	763	763	760	768	4.63
Phase 4[7] (wk 5 and 6; common diet)									
ADG,[3,6] g	726	723	610	695	689	689	690	669	5.35
ADFI,[3] g	1,126	1,162	847	1,045	1,048	1,030	1,044	1,037	6.25
G:F,[3] g/kg	647	631	721	670	665	674	668	655	4.61
Phases 1 to 4[8] (entire test)									
ADG,[3] g	539	515	424	490	490	492	497	494	4.59
ADFI,[3] g	735	742	566	676	679	672	689	683	5.32
G:F,[3] g/kg	733	699	750	728	729	732	724	725	2.98

[1]A common diet mixed at the MO station was fed during phase 1 and phase 2 of the study. A common diet mixed at each station was fed during phase 4. KY = University of Kentucky; OH = The Ohio State University; MO = University of Missouri.
[2]Effect of station ($P < 0.05$).
[3]Effect of station ($P < 0.01$).
[4]Linear effect of lactose level ($P < 0.01$).
[5]Cubic effect of lactose level ($P < 0.05$).
[6]Linear effect of lactose level ($P < 0.05$).
[7]A common phase 4 diet was fed for 7, 12.5, and 14 d (mean of 11.17 d) at the KY, OH, and MO stations, respectively.
[8]Represents 35, 40.5, and 42 d at the KY, OH, and MO stations, respectively.

period and still achieved a feed intake response to lactose.

Growth rates of pigs were improved from the inclusion of the greater levels of lactose in the diet. Although this response, when averaged across the 3 stations, to increased lactose level was linear ($P < 0.01$), the pattern of the overall response strongly suggested that the response reached a numerical plateau at the 7.5% level of lactose. Upon further examination of the data by individual stations, the relative improvements in ADG that resulted from feeding lactose levels greater than those of pigs not fed lactose were numerically greatest at the 2 greatest lactose levels (7.5 and 10% lactose) at the KY and OH stations and at a lower lactose level

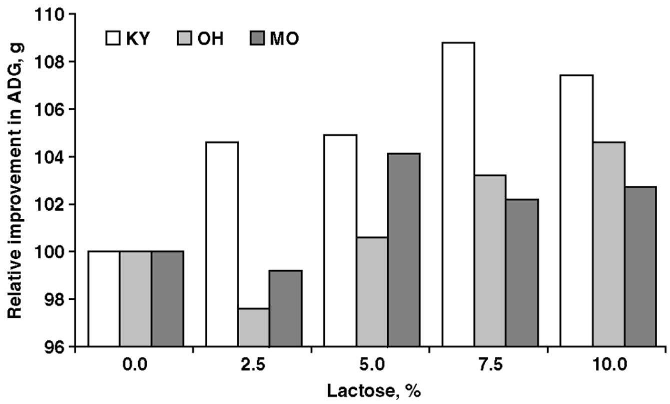

Figure 1. Relative improvements in ADG in pigs fed various levels of lactose during phase 3 (wk 3 and 4 postweaning) at the University of Kentucky (KY), The Ohio State University (OH), and the University of Missouri (MO). Each bar represents a mean of 8 pens. With 0% lactose treatment excluded, the CV was 4.65, and the lactose effect was linear ($P < 0.05$).

(5% lactose) at the MO station (Figure 1). In general, this same pattern occurred for ADFI, as shown in Figure 2.

Although lactose can be used as an energy source, it also provides carbon chains that can be used for AA synthesis and other potential carbon chains that cannot be provided from fat. Providing this additional source of carbon chain, particularly during a period when the potential for weanling growth rate is high and feed intake is somewhat depressed, may be the reason that a highly available carbon chain can be effectively used for increasing animal growth rates. The response to the greater dietary lactose levels might be greater in faster-growing pigs that are synthesizing more body muscle such as was the case in the KY pigs. The lesser response to lactose in the MO pigs was associated with decreased BW gains, which may have been due to penning in larger groups and a reduced amount of feeder space per pig. Consequently, the lean gain of the pigs, whether from genetic, management, or environmental factors, may influence the optimum level of lactose for that situation. When these various factors were consistent with increased growth performance, pigs responded to greater dietary lactose inclusion.

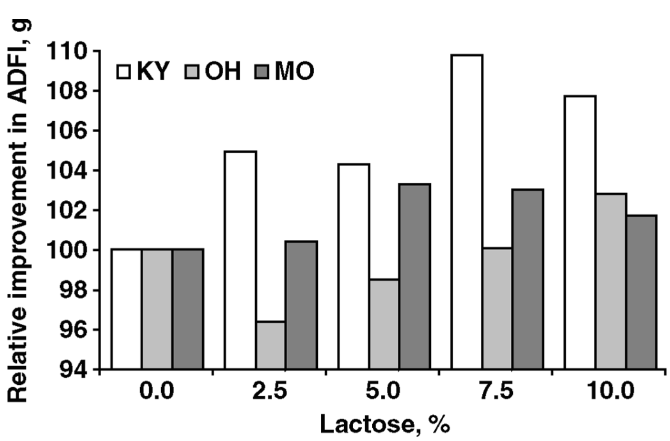

Figure 2. Relative improvements in ADFI in pigs fed various levels of lactose during phase 3 (wk 3 and 4 postweaning) at the University of Kentucky (KY), The Ohio State University (OH), and the University of Missouri (MO). Each bar represents a mean of 8 pens. With 0% lactose treatment excluded, the CV was 5.49, and the lactose effect was linear ($P < 0.05$).

Health status and intestinal environment has been shown to be greatly influenced by lactose inclusion. Milk products, and in particular their lactose component, can influence the microbiota of the stomach and intestinal tract (Partanen, 2001; Wells et al., 2005). The formation of lactic acid arises from the presence of lactose and the subsequent growth of *Lactobacillus* spp. while also lowering the *Escherichia coli* and Enterobacteria coliforms (Wells et al., 2005). The inclusion of lactose in the diet of weanling pigs was postulated to enhance the intestinal environment by reducing pathogenic bacteria and improve digestibility of the diet (Miguel and Pettigrew, 2005). Thus, the health status of the animal, the indigenous bacterial buildup in older nurseries, and factors controlling each of these environmental factors that can optimize feed intake may influence not only the consumption of lactose but may result in improved performance response.

In this experiment, the nursery facilities at the KY station were relatively new and probably had lower bacterial contamination than the facilities of the other 2 stations. The growth response in the KY trial was the greatest of the 3 stations, attributed largely to more healthy environmental conditions that stimulated pig growth responses. The results, however, clearly demonstrated a growth response to dietary lactose during the 2 to 4-wk postweaning period at each station. The impact of the various factors within a facility or group of pigs may have differed at the 3 stations, but there was a consistent response to dietary lactose during the mid to latter part of the nursery phase.

To determine whether the response to the lactose levels during phase 3 was maintained after pigs were fed a common diet without lactose, the improvement in growth rate of pigs fed the lactose diets compared with the control diet was evaluated. The 7.5% level of lactose resulted in 350 g of additional BW gain per pig during phase 3 [(557 g/d – 532 g/d) × 14 d], and this was associated with 420 g of additional feed consumed per pig during this period [(753 g/d – 723 g/d) × 14 d]. A determination of the additional BW gain from the time that the additional lactose was fed until the end of the study indicated that most of the additional BW gain (294 g/pig) was maintained throughout the study {350 g + [(690 g/d – 695 g/d) × 11.2 d in phase 4]}. The additional BW gain was associated with an additional 409 g of feed consumed per pig through the end of the study {420 g + [(1,044 g/d – 1,045 g/d) × 11.2 d in phase 4]}.

Nearly all of the additional feed consumed by this particular treatment group was during phase 3 of the study.

In summary, this study indicates that the inclusion of up to 7.5% lactose in a phase 3 diet, during the third and fourth week postweaning, results in significant increases in feed intake and growth rate. This level of lactose resulted in 350 g of additional BW gain per pig during the phase 3 period, and most of that additional gain (294 g) was maintained after the pigs received a common diet without lactose for the next 1 to 2 wk.

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