Effects of *Lactobacillus Acidophilus* L23 Supplementation on Growth Performance of Weanling Pigs Fed Low-Lactose Diets

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Story in Brief

A total of 52 weanling pigs (average BW of 11.6 lb) were used in a 42-d growth assay. Pigs were blocked by weight and randomly allotted to one of four dietary treatments. Diets were formulated to 1.5% lysine, .90% Ca, and .80% P for Phase 1 (d 0 to d 14), 1.35% lysine, .80% Ca, and .70% P for Phase 2 (d 14 to 28), and 1.2% lysine, .75% Ca, and .65% P for Phase 3 (d 28 to 42). In previous work, *L. acidophilus* L23 was found to contain relatively high levels of amylase activity. The four dietary treatments were prepared by adding 0, 1.45×10^7,1.45×10^8, and 1.45×10^9 CFU of *L. acidophilus* L23/kg to a corn-SMB-whey protein concentrate-based diet. All diets were fed in meal form. Pigs were allowed *ad libitum* access to feed and water. For Phase 1, there were no differences in ADG and ADFI between pigs fed diets with culture and without culture. Feed/gain for pigs fed diets with *L. acidophilus* L23 was improved compared to pigs fed the control diet. Within pigs fed *L. acidophilus* L23, the high level of culture tended to improve F/G compared to medium level. However, these effects disappeared during Phase 2. For Phase 3, pigs fed the highest culture level had numerically higher ADG and ADFI. However, there were no differences among the treatments. For the overall period, ADG and ADFI were similar among pigs fed the dietary treatments. However, pigs fed diets supplemented with the culture had improved F/G compared to control diet. These data indicate adding *L. acidophilus* L23 to low-lactose nursery diets improved feed efficiency.

Key Words: Nursery Pigs, *Lactobacillus Acidophilus*, Growth Performance

Introduction

Weanling pigs have a low capacity for producing endogenous amylase to digest dietary starch (Mahan and Newton, 1993). Also, illness or other stress factors, such as weaning, and changes in housing and diets can reduce enzyme production and activity. Lindemann et al. (1986) reported that endogenous enzyme activity (amylase, protease, and lipase) was reduced after weaning. A recent study by Jensen et al. (1997) found that enzyme activity was decreased by more than 50% during the first week after weaning. Thus, dietary enzyme supplementation may offer the potential to increase starch digestion immediately following weaning.

Previous studies from our station reported that *Lactobacillus acidophilus* L23 had relatively high amylase activity among twenty cultures of *Lactobacillus* (Lee et al., 2001). In vivo, administration of *Lactobacillus acidophilus* L23 improved growth performance of weanling pigs (Rincker et al., 2000). Additionally, *Lactobacillus acidophilus* L23 works as a probiotic, which increases the number of desirable microflora in the gut by decreasing intestinal pH. Pullmann et al. (1980) reported that *Lactobacillus acidophilus* increased ADG and feed efficiency of pigs fed diets supplemented with lactose. Therefore, the objective of this study was to determine the effects of dietary *Lactobacillus acidophilus* L23 on growth performance of weanling pigs fed low-lactose diets.

Materials and Methods

A total of 52 weanling pigs (average BW of 11.6 lb) were used in a 42-d growth assay. Pigs were blocked by weight and randomly allotted to one of four dietary treatments in a randomized complete block design. There were 6 pens/trt with 2 to 3 pigs/pen. Pigs were housed in an environmentally-controlled off site nursery. Each pen had a three-hole feeder and one water nipple, and pigs were allowed *ad libitum* access to feed and water.

Diets (Table 1) were formulated to 1.50% lysine, .90% Ca, and .80% P for Phase 1 (d 0 to d 14), 1.35% lysine, .80% Ca, and .70% P for Phase 2 (d 14 to 28), and 1.2% lysine, .75% Ca, and .65% P for Phase 3 (d 28 to 42). All other nutrients met or exceeded NRC (1998) standards. Freeze-dried lactic acid culture (*Lactobacillus acidophilus*- L23, Culture System, Inc., Mishawaka, IN) was added to the basal diet at four different levels. Diets were prepared weekly in order to insure viability of the culture. The culture was added to the basal diet and mixed for 3 min. Treatments were: 1) Corn-SMB-whey protein concentrate based diet; 2) Diet 1 with 1.45 x 10^7 CFU of *L. acidophilus* L23/kg of diet; 3) Diet 1 with 1.45 x 10^8 CFU of *L. acidophilus* L23/kg of diet; and 4) Diet 1 with 1.45 x 10^9 CFU of *L. acidophilus* L23/kg of diet. All diets were fed in meal form. The pigs and feeder were weighed weekly to allow calculation of ADG, ADFI, and feed/gain.

Data were analyzed as a randomized complete block design using procedures described by Steel et al. (1997) with initial BW as the blocking criterion. The model included the effects of block, treatment, and block x treatment (error). Orthogonal contrasts were used to separate treatment means and consisted of 1) control vs enzyme, 2) low vs medium and high, and 3) medium vs high. In all cases, pen served as the experimental unit.

Table 1. Composition of diet

Ingredient, %	Phase 1 (d 0 to 14)	Phase 2 (d 14 to 28)	Phase 3 (d 28 to 42)
Corn	66.74	68.18	65.16
Soybean meal	11.40	17.73	31.51
Whey protein concentrate[a]	15.00	7.50	0
L-lysine	.19	.20	.10
L-threonine	.05	.05	.08
DL-methionine	.06	.06	.04
Soy protein concentrate	3.00	3.00	0
Dicalcium phosphate	2.26	1.71	1.35
Limestone	.51	.71	.91
Sodium chloride	.50	.50	.50
TM/Vit Premix	.20	.25	.25
Antibiotic[b]	.10	.10	.10
Calculated analysis			
ME, kcal/kg	2,772	3,036	3,293

CP, %	24.65	22.02	20.55
Lysine, %	1.50	1.35	1.20
Ca, %	.90	.80	.75
P, %	.80	.70	.65
[a]Whey protein concentrate contained less than 1% lactose, and 77 % CP (ALACEN® 866, New Zealand Milk Products). [b]Provided 100 mg oxytetracycline and 140 mg of neomycin per kg of complete diet.			

Results and Discussion

For Phase 1 (d 0 to 14), there were no differences (P>.10) in ADG and ADFI between pigs fed diets without culture or with culture (Table 2). However, feed/gain was improved (P<.03) for pigs fed diets with culture compared to pigs fed the control diet. Within pigs fed the culture, the high level of culture tended to improve F/G (P<.07) compared to the medium level. However, these effects disappeared during Phase 2 (d 14 to 28). For Phase 3 (d 28 to 42), pigs fed the highest culture dose had numerically higher ADG and ADFI. However, there were no differences (P>.10) among the treatments. For the overall period (d 0 to 42), ADG and ADFI were similar (P>.10) among pigs fed the dietary treatments. However, F/G was improved (P<.05) for pigs fed diets supplemented with culture compared to pigs fed control diet. These data indicate that *L. acidophilus* L23 supplementation improved growth performance of pigs immediately following weaning.

These results are consistent with a previous study in our lab (Rincker et al., 2000), which reported administration of *L. acidophilus* L23 at 24-h intervals improved ADG and feed/gain compared to control pigs, but there was no difference between pigs administered different levels of culture. However, Jensen et al. (1997), Makkink et al. (1994), and Lindemann et al. (1986) reported that enzyme production was decreased in weaned pigs. The improvement in growth performance, mainly found during Phase 1, may be due to the increased endogenous amylase activity derived from *L. acidophilus* L23, which improved utilization of dietary starch.

Table 2. Effects of *Lactobacillus acidophilus* L23 on growth performance of weanling pigs[a]

Item	Treatments[b]					Probability [c]		
	Control	Low	Medium	High	SE	1	2	3
Phase 1 (d 0 to 14)								
ADG, lb	.36	.42	.37	.47	.04	--[d]	--	--
ADFI, lb	.47	.47	.44	.50	.04	--	--	--
F/G	1.28	1.13	1.21	1.07	.05	.03	--	.07
Phase 2 (d 14 to 28)								
ADG, lb	1.10	1.06	1.06	1.08	.05	--	--	--
ADFI, lb	1.68	1.56	1.62	1.65	.07	--	--	--
F/G	1.52	1.47	1.53	1.51	.04	--	--	--
Phase 3 (d 28 to 42)								

ADG, lb	1.14	1.16	1.16	1.28	.05	--	--	--
ADFI, lb	1.91	1.86	1.85	2.05	.08	--	--	--
F/G	1.67	1.61	1.59	1.62	.05	--	--	--
Overall (d 0 to 42)								
ADG, lb	.97	.97	.97	1.05	.03	--	--	--
ADFI, lb	1.50	1.43	1.45	1.55	.06	--	--	--
F/G	1.55	1.48	1.50	1.48	.02	.05	--	--

[a]Least squares means for 6 pens/treatment of 2 to 3 pigs/pen.

[b]Contol = Corn-SMB-WPC based diet; Low = Basal diets with 1.45 % 10^7 CFU of *L. acidophilus*/kg of diet; Medium = Basal diet with 1.45 % 10^8 CFU of *L. acidophilus*/kg of diet; High= basal diet with 1.45 % 10^9 CFU of *L. acidophilus*/kg of diet

[c]Contrasts were: 1) Control vs enzyme; 2) Low vs Medium and High; and 3) Medium vs High.

[d]Dashes indicate P>.10.

Implications

Supplementation of dietary *L. acidophilus* L23 tended to improve gain and feed efficiency of weanling pigs fed low-lactose diets. This improvement may be due to the endogenous amylase activity derived from the *L. acidophilus* L23 added to the diet. These data indicate that a culture level as low as 1.45 x 10^7 CFU of *L. acidophilus* L23/kg of diet improved feed/gain of weanling pigs, suggesting improved starch availability in weanling pigs fed low-lactose diets. More investigation is needed to determine the optimum inclusion rate in terms of growth and cost effectiveness.

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