

Influence of *Lactobacillus brevis* 1E-1 on the Gastrointestinal Microflora, Gut Morphology, and Growth Performance of Weanling Pigs Pre- and Post-Weaning

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Story in Brief

Two experiments were conducted to determine the effect of milk supplementation with *Lactobacillus brevis* (1E-1) on pre- and post-weaning pig performance, intestinal microflora, and gut morphology. In both experiments, litters were allotted to two treatments at farrowing: 1) control milk supplement, and 2) as 1, with 1E-1. During the first 5 days post-weaning ($P < 0.06$) and from d 0 to 14 post-weaning ($P < 0.05$) of Exp. 1, pigs fed 1E-1 prior to weaning had greater ADG compared to pigs provided only milk supplement. Coliforms and *E. coli* were enumerated from esophageal, duodenal, jejunal, and ileal regions of the enteric tracts, and gut morphology was assessed in both experiments. In Exp. 1, pigs receiving 1E-1 had lower ($P < 0.05$) jejunal *E. coli* populations pre-weaning, and lower jejunal ($P < 0.10$) and ileal ($P < 0.02$) *E. coli* populations at weaning compared to pigs provided milk supplement. In Exp. 2, 1E-1 reduced coliform populations in the jejunum ($P < 0.10$) and ileum ($P < 0.05$) at weaning. Pigs provided 1E-1 had greater ($P < 0.05$) ileal villus:crypt ratio at 10 d of age compared to control pigs, although there was no difference at 21 and 28 d of age (interaction, $P < 0.05$). These data indicate that milk supplementation with 1E-1 during lactation improves subsequent nursery performance and may provide a healthier intestinal environment.

Introduction

Recently there has been concern about the use of antibiotics in animal production in part due to the emergence of antimicrobial resistant bacteria. Over the past two decades, probiotics (direct-fed microbials), which include *Lactobacillus* cultures, have been used as an alternative to antibiotics in animal production (Jin et al., 1998). *Lactobacilli* are normal inhabitants of the gastrointestinal tract of pigs. Their beneficial role in the intestinal tract has been attributed to their ability to survive the digestive process, attach to the epithelial lining of the intestinal tract, produce lactic acid and other microbial compounds and prevent the colonization of pathogens via competitive exclusion (Savage, 1987). Maintaining a healthy intestinal microflora despite the changes that occur at weaning is crucial for subsequently optimizing pig growth. To investigate weaning-induced changes within the enteric system, two experiments were conducted to determine the effect of milk supplementation with *Lactobacillus brevis* (1E-1) on pre- and post-weaning pig performance, intestinal microflora, and gut morphology.

Experimental Procedures

In each experiment, litters were randomly allotted to two treatments at farrowing: either a control milk supplement, or the control containing 1E-1. Milk supplement was supplied to the pigs ad libitum via an in-line system in a small bowl supplied by a central 30-gallon tank. The tank was equipped with a hydro pump with a pressure regulator that pumped the milk supplement to the pens as needed. A baby pig nipple inside each bowl allowing milk to flow into the bowl only when touched by a pig's nose was used to minimize spillage and waste of the milk supplement. On a daily basis, the entire system was flushed with hot water to remove spoiled milk or sediment, and fresh milk was prepared using a commercial milk replacer (Merrick's Litter-Gro, Merrick's, Inc., Union Center, WI).

Coliforms and *E. coli* were enumerated from esophageal, duodenal, jejunal, and ileal regions of the enteric tracts, and gut mor-

phology (villus:crypt ratio and goblet cell enumeration) was assessed from one pig/litter at approximately 10 (pre-weaning) and 22 (weaning) days of age in Exp. 1 and 2, and after weaning at 28 days of age in Exp. 2. Pigs were euthanized and duodenal, jejunal, and ileal intestinal sections were evaluated for the enumeration of bacterial populations using polymerase chain reaction (PCR) techniques. Additionally, duodenal and ileal samples from the small intestine were obtained for histology in the evaluation of villus height, crypt depth, villus:crypt ratio, and neutral, acidic, and sulfuric mucin-producing goblet cells.

Data in both experiments were analyzed as a completely randomized design. Analysis of variance was performed using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC).

Results and Discussion

Growth performance. During the first 5 days after weaning ($P < 0.06$) and from d 0 to 14 post-weaning ($P \leq 0.05$) of Exp. 1, pigs fed 1E-1 prior to weaning had greater ADG compared to pigs provided only milk replacer (Figure 1). In Exp. 2, 1E-1 supplementation did not affect pig growth performance during the pre- or post-weaning periods. This discrepancy in performance response between the two experiments is likely due to the lower level of coliforms present in the control pigs in Exp. 2 compared to Exp. 1 (data not reported).

Intestinal Microflora. In Exp. 1, pigs receiving 1E-1 had lower ($P < 0.05$) jejunal *E. coli* populations pre-weaning and at weaning compared to pigs provided only milk supplement (Table 1). Ileal *E. coli* populations were lower ($P < 0.05$) at weaning for pigs receiving 1E-1 compared to pigs provided milk supplement without 1E-1. In Exp. 2, 1E-1 reduced coliform populations in the jejunum ($P < 0.10$) and ileum ($P < 0.01$) at weaning; however, populations in control pigs were 99% to 99.9% lower than in Exp. 1 (Table 1). In a previous study (Parrott et al., 1994), the intestinal tracts from 10 healthy pigs and five pigs with scours were sampled, and it was reported that healthy pigs had higher levels of *Lactobacilli*, with the majority of isolates identified as *Lactobacillus brevis*. The administration of 1E-1 prior to weaning may deter the detrimental alterations in the micro-

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bial population that occur at weaning (Katouli et al., 1999).

Intestinal Morphology. In Exp. 2, pigs provided 1E-1 had greater ($P < 0.05$) ileal villus:crypt ratio at 10 days of age compared to control pigs, although there was no difference at 21 and 28 days of age (interaction, $P < 0.05$; Figure 2). The number of duodenal sulfuric goblet cells was somewhat less ($P < 0.06$) when pigs were provided 1E-1 compared to control pigs at 10 days of age, although there was no difference at 21 and 28 days of age (interaction, $P = 0.06$; Figure 3). Sulphomucins are normally absent from the small intestine, but can be produced by crypt goblet cells when the small intestinal mucosa is altered (Specian and Oliver, 1991). The lower number of sulfuric goblet cells, combined with the increase in villus:crypt ratio in 1E-1-supplemented pigs suggests that 1E-1 affords some protection from the intestinal disruption that occurs at weaning.

Implications

Supplementation with *Lactobacillus brevis* bacteria has the potential to enhance post-weaning growth, and decrease *E. coli* and

coliform populations in the small intestine. The observed decrease in potentially pathogenic bacterial populations and improvements in intestinal morphology after weaning indicate that *Lactobacillus brevis* may protect the newly-weaned pig from detrimental changes in the intestinal microflora at weaning and improve intestinal morphological structure.

Literature Cited

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 Parrott, T.D., et al. 1994. 93rd General meeting of the American Society of Microbiology, Las Vegas NV.
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Table 1. Pre- and post-weaning mean *E. coli* and coliform populations in the jejunum and ileum of pigs.

	Pre-weaning		Post-weaning	
	Control	1E-1	Control	1E-1
Experiment 1				
Mean <i>E. coli</i> (cfu/g(log ¹⁰))				
Jejunum	5.53 ^a	3.42 ^b	7.10 ^a	4.80 ^b
Ileum	5.91	4.71	6.63 ^a	4.96 ^b
Experiment 2				
Mean coliforms (cfu/g(log ¹⁰))				
Jejunum	2.98	1.30	2.36 ^c	1.00 ^d
Ileum	4.54	3.82	5.77 ^a	3.02 ^b

a,b Pre- and post-weaning means within a row with no letter in common differ ($P < 0.05$).

c,d Pre- and post-weaning means within a row with no letter in common differ ($P < 0.10$).

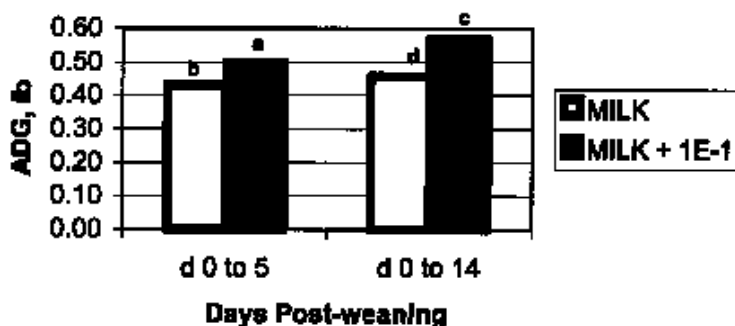


Figure 1. Average daily gain of pigs provided milk supplementation or milk with 1E-1 supplementation during d 0 to 5 (SEM = 0.06) and d 0 to 14 (SEM = 0.04) after weaning in Experiment 1. Means within each post-weaning period with no letter in common differ (a,b $P < 0.06$; c,d $P < 0.05$).

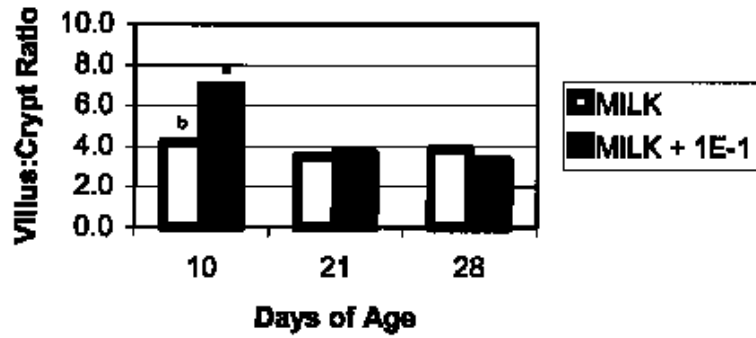


Figure 2. Villus:crypt ratio measured from small intestinal ileal samples obtained from pigs at 10, 22, and 28 d of age in Experiment 2 (interaction, $P < 0.05$). a,b Means within each age group with no letter in common differ ($P < 0.05$).

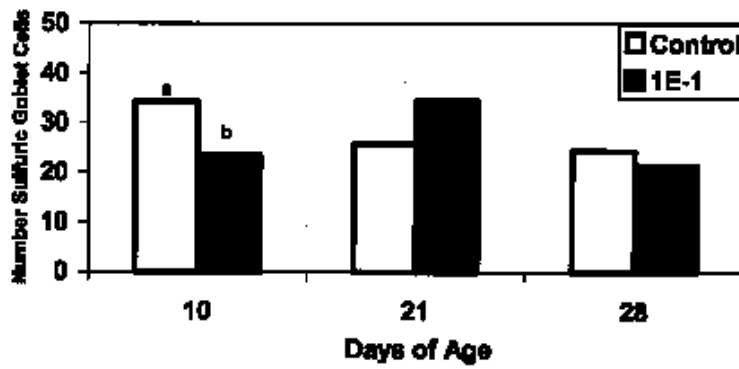


Figure 3. Number of sulfuric goblet cells in the duodenum of pigs on d 10, 21, and 28 of age in Experiment 2 (interaction, $P = 0.06$). a,b Means within each age group with no letter in common differ ($P < 0.06$).