Effect of Probiotic Supplementation on Performance, Fecal Parameters and Digestibility in Growing-finishing Swine

C. V. Maxwell[1], D. S. Buchanan[2], F. N. Owens[3]
S. E. Gilliland[4], W. G. Luce[5] and R. Vencl[6]

Story in Brief

To evaluate two commercial probiotics (Feed-Mate 68 and Primalac), 581 crossbred pigs were allotted within breed to 36 pens and to 3 treatment groups. Effects on performance, fecal parameters and digestibility of growing and finishing swine were measured. Daily gain was improved ($P < .05$) by feeding either probiotic during the growing period. During the finishing phase, pigs fed Feed-Mate 68 grew faster ($P < .05$) than those fed Primalac. For the overall feeding period, pigs fed Feed-Mate grew 2.6 percent faster ($P < .05$) than pigs fed either the negative control diet or Primalac. Though feed efficiency and feed intake were not significantly improved by probiotic feeding, both tended to be superior in the growing and finishing periods when probiotics were added to the diet. Lactobacillus and coliform counts on pooled fecal samples (3 pigs per pen) indicated that lactobacilli and coliform populations were similar among treatments one week prior to the initiation of the trial, at the initiation of the trial and at the end of the trial. Likewise, fecal ammonia, pH and urease activity were similar among treatments. Apparent digestibility of dry matter and nitrogen, estimated with chromic oxide as pigs approached 100 kg, was 6.0 and 7.8 percent greater ($P < .05$), respectively in pigs fed both probiotics compared to the control diet.

Introduction

Probiotic products are being manufactured commercially in the United States and a number are being offered for sale to swine producers in Oklahoma. Very little research information is available concerning the effectiveness of these products for growing-finishing pigs. This study was conducted to determine the effect of probiotics on gain and efficiency of gain in growing-finishing swine. In addition, the effect of probiotics on digestibility and fecal pH, urease activity and ammonia concentration, indicators of microbial activity, was evaluated.

Materials and Methods

A total of 581 pigs from the Southwestern Livestock and Forage Research Station near El Reno, OK were used to evaluate two commercial probiotic

[1]Associate Professor, Animal Science Dept. [2]Assistant Professor, Animal Science Dept.
[3]Professor, Animal Science Dept. [4]Professor, Animal Science Dept. [5]Professor, Animal Science Dept.
[6]Herd Manager, Ft. Reno Research Station

products. All pigs were housed in indoor concrete pens equipped with self-feeders and waterers. Pigs from various breed groups were randomly allotted within breed group to the three experimental treatments (Table 1). Effects of probiotics on performance, fecal parameters and digestibility of growing (41.4 to 120.1 lb) and finishing (120.1 to 224.6) swine were measured. Treatments were (1) a ground wheat-soybean meal diet (2) diet 1 plus 2.5 lbs of Feed-Mate 68[7] per ton of feed during both the growing and finishing periods and (3) diet 1 plus 2.2 lb of Primalac[8] per ton of feed during both the growing and finishing periods. To ensure that all pigs were exposed to the bacteria present in the probiotics in sufficient quantities, both probiotics were included in the diet at twice the recommended level (5.0 and 4.4 lb of Feed-Mate 68 and Primalac per ton of feed for treatments 1 and 3, respectively) for one week prior to the initiation of the growth study. In addition, special precautions were taken to avoid cross contamination of feed with either probiotic during mixing or transport of feed. Feed supplement samples were obtained at intervals throughout the study for determination of viable microbial counts. The samples were diluted and plated on MRS agar and on LBS agar. Fecal samples were obtained from 3 pigs from each pen at one week prior to the initiation of the trial, at the initiation of the trial and at the end of the trial and pooled for determination of numbers of facultative lactobacilli and coliforms. Samples were chilled immediately after they were obtained and counting procedures were

Table 1. Composition of experimental rations.

Ingredient	Growing %	Finishing %
Wheat	81.48	86.90
Soybean Meal	15.40	10.15
Dicalcium phosphate	1.40	1.25
Calcium carbonate	0.97	0.95
Salt	0.50	0.50
Vitamin-trace mineral mix[a]	0.25	0.25
Feed-Mate 68 and Primalac[b]	----	----
Total	100.00	100.00
Lysine, %	.75	.62
Calcium, %	.75	.70
Phosphorus, %	.65	.60

[a]Supplied 4,000,000 IU vitamin A, 300,000 IU vitamin D, 4 g riboflavin, 20 g pantothenic acid, 30 g niacin, 800 g choline chloride, 15 mg vitamin B_{12}, 10,000 IU vitamin E, 2 g menadione, 200 mg iodine, 90 g iron, 20 g manganese, 10 g copper, 90 g zinc and 100 mg selenium per ton of feed.

[b]Feed-Mate 68 was added at the rate of 2.5 lbs per ton and Primalac was added at the rate of 2.2 lbs per ton for treatments 2 and 3, respectively.

[7]Anchor Labs, Inc., St. Joseph, Missouri - Contains *Streptococcus faecium* strain Cernell 68, *Lactobacillus acidophilus* and *Lactobacillus Plantarum*.

[8]Star Labs, St. Joseph, Missouri - Contains *Lactobacillus acidophilus, Lactobacillus casei, Bifidobacterium bifidum, Torulophsis* and *Aspergillus oryzae*.

initiated the same day samples were obtained. Coliforms were enumerated on Violet Red Bile Agar and facultative lactobacilli were enumerated on Lactobacillus Selection (LBS) Agar incubated in a CO_2 enriched atmosphere.

A digestion trial with five randomly selected pigs from each pen was conducted as pens of pigs approached 220 lbs. Chromic oxide was added to the feed and each diet was available ad libitum for a 4-day presampling period. Pens were washed down daily to minimize copraphagy. Fecal samples were obtained from the first 3 pigs defecating after the initiation of fecal collection on day 5 of the digestion trial and pooled for pH determination. Samples were chilled for subsequent determination of urease activity and ammonia concentrations the day of sampling and then frozen for subsequent dry matter, nitrogen and chromic oxide determinations.

Backfat was estimated on each pig using an ultrasonic instrument as pigs were weighed off test at 220 lbs.

Results and Discussion

To determine if viable organisms were maintained in the feed supplements, microbial counts were made on samples obtained under field storage conditions at three time intervals during the experiment (Table 2). The experiment was initiated on May 12, 1981. Viable lactobacilli were present in both probiotics used in this study although viability declined during the course of the experiment. *Streptococcus faecium* present in Feed-Mate 68 also will form colonies on the lactobacillus selection agar. Thus the decline in numbers on LBS agar may also indicate a decline in numbers of *S. faecium.* The counts on MRS agar also indicated a decline of microbial numbers during storage. If probiotics are to produce improvements in growing and finishing swine due to their content of viable microorganisms, it is important that those microorganisms remain alive during storage of the supplement and feed. Greater differences may have been observed in this study if the numbers of microorganisms had not declined during storage of the supplements. The decline in numbers of live microorganisms which we observed points out a problem that must be overcome if we are to realize full benefit from supplementing livestock feed with live microbial cultures.

Results for the growing, finishing and growing-finishing periods are presented in Table 3. Average daily gain was improved ($P < .05$) by feeding either probiotic during the growing period. During the finishing period, pigs fed Feed-Mate 68 grew faster ($P < .05$) than pigs fed either the negative con-

Table 2. Viable microbial counts in the feed supplements during storage.

	Counts/g			
	Feed-Mate 68		Primalac	
Date	LBS[a]	MRS[b]	LBS[a]	MRS[b]
5-22-81	3.2×10^7	6.4×10^7	3.0×10^5	1.4×10^6
6-9-81	7.8×10^6	2.4×10^7	2.8×10^4	5×10^5
10-19-81	2.4×10^4	2.0×10^6	10^3	5×10^3

LBS[a] = Lactobacillus selection agar.
MRS[b] = Mann Rogosa and Sharp agar (non selective).

Table 3. Effect of probiotics on performance of growing, finishing and growing-finishing swine.

Item	Treatments 1 Control	2 Feed-Mate 68	3 Primalac
Pigs per treatment, no.[a]	135	223	223
Pens per treatment	8	14	14
Growing (41.4 to 120.1 lb)			
Avg. initial wt, lb	42.1	41.4	40.9
Avg. final wt, lb	117.0	121.4	120.7
Avg. daily gain, lb	1.35[b]	1.41[c]	1.40[c]
Avg. daily feed intake, lb	3.66	3.74	3.72
Feed per lb gain, lb	2.76	2.68	2.71
Finishing (120.1 to 224.6 lb)			
Avg. initial wt, lb	117.0	121.4	120.7
Avg. final wt, lb	225.7	225.0	224.3
Avg. daily gain, lb	1.73[bc]	1.76[b]	1.71[c]
Avg. daily feed intake, lb	5.82	6.04	5.94
Feed per lb gain, lb	3.56	3.49	3.39
Growing-finishing (41.4 to 224.6 lb)			
Avg. daily gain, lb	1.55[b]	1.59[c]	1.55[b]
Avg. daily feed intake, lb	4.80	4.90	4.86
Feed per lb gain, lb	3.21	3.13	3.09
Avg. adj. backfat, in.	0.85	0.85	0.86

[a]During the finishing period, a total of 132, 214 and 221 pigs were on treatments 1, 2 and 3, respectively.
[bcd]Values in each row with different superscripts differ ($P < .05$).

trol diet or Primalac. For the overfall feeding period, pigs fed Feed-Mate 68 grew faster ($P < .05$) than those fed either the negative control diet or Primalac. There was a trend during the combined growing and finishing periods for improved average daily feed intake and feed efficiency when probiotics were added to the diet, although these differences were not significant. Adjusted backfat thickness was similar for all treatments.

Lactobacillus and coliform counts on pooled fecal samples (3 pigs from each pen, Table 4) indicated that the numbers of lactobacilli and coliforms were not different among treatments at one week prior to the initiation of the trial, at the initiation of the trial and at the end of the trial.

The effect of probiotics on fecal parameters and digestibility of dry matter and nitrogen are presented in Table 5. Fecal pH tended to be lower in feces from pigs fed probiotics, although these differences were not significant. Similarly urease activity was 20 percent lower in pigs fed Primalac than those fed the untreated control diet and fecal ammonia was reduced by 11.2 percent when probiotics were added to the diet, but these differences were not significant. Visek (1978) has suggested that a decrease in ammonia either with urease immunization or antibacterial agents alters the histology of the gastrointestinal tract. Both nitrogen and dry matter digestibility were higher ($P < .01$) in pigs fed probiotics.

Table 4. Effect of probiotics on fecal lactobacilli and coliforms.

	Treatments		
	1 Control	2 Feed-Mate 68	3 Primalac
Log_{10} lactobacilli per g of dry feces			
Sample 1, 1 week prior to trial initiation	9.93	9.90	10.08
Sample 2, trial initiation	10.08	10.01	9.89
Sample 3, end of trial	9.41	8.96	9.28
Log_{10} coliforms per g of dry feces			
Sample 1, 1 week prior to trial initiation	6.96	7.16	7.42
Sample 2, trial initiation	7.66	7.20	7.27
Sample 3, end of trial	6.88	6.63	6.77

Table 5. The effect of probiotics on fecal measurements and digestibility of dry matter and nitrogen.

	Treatments		
Item	1 Control	2 Feed-Mate 68	3 Primalac
pH	6.28	6.15	6.18
Urease, summer units[a]	1.58	1.54	1.26
Ammonia Mg/100 g wet feces	69.3	61.4	61.6
Nitrogen digestibility, %	65.39[b]	69.76[c]	71.16[c]
Dry matter digestibility, %	67.7[a]	71.0[b]	72.5[b]

[a]Release of 1 mg of ammonia per 5 min.
[bc]Values in each row with different superscripts are different ($P < .01$).

Literature Cited

Visek, W. J. 1978. Jl Anim. Sci. 46:1447.