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Abstract

Two hundred fifty-five pigs, weaned at 4 wk of age, were used in an experiment to compare the efficacy of Bacillus subtilis and antibiotics as growth promoters for swine from nursery to finishing. Treatments were a nonmedicated control; B. subtilis added at 5 x 105, 1 X 106, or 5 x 106 CFU/g feed; or antibiotics (50 g/ton carbadox during the nursery phase and 100 g/ton chlortetracycline in the growing and finishing phases). Average daily gain and average daily feed intake were greater for pigs fed antibiotics in the nursery and grower phases than for pigs fed diets containing no medication or diets containing B. subtilis. Feed to gain ratio was not affected by the addition of B. subtilis or antibiotics. In the finishing phase, feeding B. subtilis and antibiotic did not affect avg daily gain, avg daily feed intake, or feed to gain ratio. From weaning to market weight, avg daily gain and avg daily feed intake were greater for pigs fed antibiotics than pigs fed the other treatments. Our results indicate that at the levels used in this experiment, feeding B. subtilis is not as effective as feeding antibiotics to improve performance of nursery and growing pigs. Neither B. subtilis nor chlortetracycline affected the performance of finishing pigs.; Swine Day, Manhattan, KS, November 16, 1989

Keywords

Swine day, 1989; Kansas Agricultural Experiment Station contribution; no. 90-163-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 581; Swine; Pig; Bacillus subtilis; Antibiotics; Growth performance

GROWTH RESPONSE TO DIETARY ADDITIONS OF *BACILLUS SUBTILIS* FROM WEANING TO 230 POUNDS

J. A. Swanson and J. D. Hancock

Summary

Two hundred fifty-five pigs, weaned at 4 wk of age, were used in an experiment to compare the efficacy of *Bacillus subtilis* and antibiotics as growth promoters for swine from nursery to finishing. Treatments were a nonmedicated control; *B. subtilis* added at 5×10^5, 1×10^6, or 5×10^6 CFU/g feed; or antibiotics (50 g/ton carbadox during the nursery phase and 100 g/ton chlortetracycline in the growing and finishing phases). Average daily gain and average daily feed intake were greater for pigs fed antibiotics in the nursery and grower phases than for pigs fed diets containing no medication or diets containing *B. subtilis*. Feed to gain ratio was not affected by the addition of *B. subtilis* or antibiotics. In the finishing phase, feeding *B. subtilis* and antibiotic did not affect avg daily gain, avg daily feed intake, or feed to gain ratio. From weaning to market weight, avg daily gain and avg daily feed intake were greater for pigs fed antibiotics than pigs fed the other treatments. Our results indicate that at the levels used in this experiment, feeding *B. subtilis* is not as effective as feeding antibiotics to improve performance of nursery and growing pigs. Neither *B. subtilis* nor chlortetracycline affected the performance of finishing pigs.

(Key Words: Pig, *Bacillus subtilis*, Antibiotics, Growth Performance.)

Introduction

The addition of antibiotics to swine diets is a routine practice among feed companies and producers throughout the United States. Feeding antibiotics has resulted in consistent improvements in starter, grower, and finishing pig growth performance by giving protection against disease, as well as having non-specific growth promoting effects. But recent concern about antibiotic residues in the U.S. meat and milk supply has stimulated interest in the development of alternative products to be used as growth promoters in livestock feeding. New products are being developed to enhance growth and protect against digestive disorders by encouraging a "healthy" balance of microbial populations in the intestines. These products are cultures of nonpathogenic microbes or compounds that stimulate proliferation of these nonpathogenic organisms and are collectively called probiotics. The objective of the experiment reported herein was to determine if a *B. subtilis* culture could be used to replace antibiotics in diets for nursery, growing, and finishing pigs.

Experimental Procedures

Two hundred fifty-five pigs were allotted to five treatments based on weight, sex, and ancestry. The pigs were housed in an open-front building with a solid concrete floor. At weaning, the pigs were fed diets (Table 1) containing: no antibiotics (negative control); *B. subtilis* at 5 × 10^5, 1 × 10^6, or 5 × 10^6 CFU/g feed; or antibiotics (50 g/ton carbadox during the nursery phase and 100 g/ton chlortetracycline during the growing and finishing phases[1]). Samples were taken from each batch of feed and analyzed for *B. subtilis* content. Pigs were given the same treatments in the nursery, growing, and finishing phases. Feed and water were supplied ad libitum. Feed additions were recorded, and pigs and feeders were weighed at wk 5 to end the nursery phase, at 121 lb to end the grower phase, and every 4 wk thereafter until the first pen in a weight block averaged 230 lb. Response criteria were avg daily gain (ADG), avg daily feed intake (ADFI), and feed to gain ratio (F/G).

Table 1. Composition of Diets, %[a]

Ingredient	Phase of production		
	Nursery	Grower	Finisher
Corn	47.82	75.26	81.36
Soybean meal (48%)	21.65	21.10	15.40
Dried whey	20.00	--	--
Fish meal	4.00	--	--
Soybean oil	3.00	--	--
Vitamins and minerals	2.33	3.14	2.75
Lysine-HCl	.10	--	--
Treatment premix[b]	1.1	.50	.50

[a]Diets were formulated to contain 1.25% lysine, .9% calcium, .8% phosphorus in the nursery phase; .8% lysine, .75% calcium, .65% phosphorus in the growing phase; .65% lysine, .65% calcium, .55% phosphorus in the finishing phase.
[b]Provided the following: Negative control = ground corn; 5 × 10^5 CFU *B. subtilis*/g of feed; 1 × 10^6 CFU *B. subtilis*/g of feed; 5 × 10^6 CFU *B. subtilis*/g of feed; or 50 g/ton carbadox in the nursery phase and 100 g/ton chlortetracycline in the growing and finishing phases.

Results and Discussion

Feed samples were taken before and after pelleting of the nursery diets to determine the effects of pelleting on *B. subtilis* counts. The results (Table 2) show a marked decrease in the number of viable *B. subtilis* in the nursery diets after pelleting. Thus, feed manufacturers need to allow for loss of microbes if a diet is pelleted.

B. subtilis counts of the diets fed in this experiment are given in Table 3. Counts of the non-medicated control and the diets containing antibiotic were very similar. Counts for the three diets with *B. subtilis* added were close to the targeted values. Therefore, it appears that the test product contained viable organisms, and that those organisms were being fed.

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[1]Carbadox was Key-MX Pak-20®, Fourth & Pomeroy Assoc., Inc., Clay Center, KS, and chlortetracycline was Pfichlor 50®, Pfizer, Inc., New York, NY.

Table 2. Effect of Pelleting on *Bacillus subtilis* Counts in Mixed Feed

Item	Unmedicated control	CFU *B. subtilis* added/g feed 5×10^5	1×10^6	5×10^6	Antibiotic[a]	CV
Pre-pelleted feed						
B. subtilis count, log 10	5.23	5.49	5.82	6.34	5.22	42.9
(actual)	(190,000)	(346,667)	(696,667)	(2,200,000)	(193,333)	
Pelleted feed						
B. subtilis count, log 10	4.74	5.11	5.05	5.97	4.78	5.1
(actual)	(99,000)	(143,333)	(120,000)	(1,026,667)	(62,333)	

[a]50 g/ton carbadox added to the feed.

Table 3. *Bacillus subtilis* Counts in Feed

Item	Unmedicated control	CFU *B. subtilis* added/g feed 5×10^5	1×10^6	5×10^6	Antibiotic[a]	CV
Nursery diets (pelleted)						
B. subtilis count, log 10	4.74	5.11	5.05	5.97	4.78	6.2
(actual)	(99,000)	(143,333)	(120,000)	(1,026,667)	(62,333)	
Grower diets (meal)						
B. subtilis count, log 10	5.66	5.70	6.01	6.56	5.53	4.0
(actual)	(546,000)	(550,000)	(1,040,000)	(4,160,000)	(390,000)	
Finisher diets (meal)						
B. subtilis count, log 10	5.72	5.97	6.16	6.67	5.83	4.5
(actual)	(788,571)	(972,857)	(1,542,857)	(4,757,143)	(760,000)	

[a]50 g/ton carbadox added to the nursery diet; 100 g/ton chlortetracycline added to the growing and finishing diets.

Performance data are given in Table 4. Avg daily gain and ADFI were greater for pigs fed antibiotics than for pigs fed the nonmedicated control diet in the nursery and grower phases ($P<.01$). Avg daily gain, ADFI, and F/G were not affected by the addition of *B. subtilis* for the nursery, growing, or finishing phases ($P>.10$). Overall, ADG and ADFI were significantly higher ($P<.001$) for pigs fed diets containing antibiotics, with no beneficial effect from the addition of *B. subtilis*.

We conclude that the *B. subtilis* product used in this experiment did contain viable organisms. Counts of these organisms in the feed were greatly reduced when the products were added prior to pelleting. At the concentrations used in this experiment, the addition of *B. subtilis* did not affect performance of pigs from weaning to 230 lb. Alternatively, pig performance in the nursery and grower periods was greater for the pigs fed antibiotics than for pigs fed either *B. subtilis* or the nonmedicated control.

Table 4. Growth Response of Pigs to *Bacillus subtilis*[a]

Item	Unmedicated control	CFU *B. subtilis* added/g feed			Antibiotic[b]	CV
		5×10^5	1×10^6	5×10^6		
Nursery phase (19 to 52 lb)						
ADG, lb[cd]	.90	.84	.90	.90	1.11	9.3
ADFI, lb[cd]	1.43	1.38	1.40	1.44	1.66	5.9
F/G[e]	1.59	1.64	1.56	1.60	1.50	8.9
Grower phase (52 to 121 lb)						
ADG, lb[fg]	1.58	1.59	1.55	1.60	1.72	5.8
ADFI, lb[gh]	3.83	3.85	3.79	3.88	4.24	6.1
F/G[e]	2.42	2.42	2.45	2.43	2.47	4.9
Finishing phase (121 to 221 lb)						
ADG, lb[e]	1.80	1.87	1.77	1.83	1.84	6.0
ADFI, lb[e]	5.96	6.05	6.00	6.11	6.19	4.8
F/G[e]	3.31	3.24	3.39	3.34	3.36	3.7
Overall (19 to 221 lb)						
ADG, lb[cd]	1.49	1.51	1.47	1.52	1.61	3.4
ADFI, lb[dh]	4.07	4.10	4.06	4.16	4.37	3.4
F/G	2.73	2.72	2.76	2.74	2.71	2.6

[a]Six pens per treatment (three pens of ten pigs and three pens of seven pigs per treatment).
[b]50 g/ton carbadox in the nursery phase and 100 g/ton chlortetracycline in the growing and finishing phases.
[c]Control vs antibiotic ($P<.001$).
[d]*B. subtilis* vs antibiotic ($P<.001$).
[e]No treatment effect ($P>.10$).
[f]Control vs antibiotic ($P<.05$).
[g]*B. subtilis* vs antibiotic ($P<.01$).
[h]Control vs antibiotic ($P<.01$).