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Dose-response of weanling pigs to streptococcus faecium

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Abstract

Two 5-wk experiments, using a total of 270 pigs (avg initial wt of 16.1 and 13.11b), were conducted to determine the dose-response relationship between Streptococcus faecium additions to drinking water and performance of newly weaned pigs. In experiment 1, treatments were: 1) untreated control; 2, 3, and 4) .5, 2.5, and 4.5 x 109 CFU of S. faecillm/pig/d; 5) antibioticfed positive control (CSP250 and CUS04)' Bacterial content of feces collected from the pigs on d 7, 14, and 21 indicated that antibiotic feeding greatly reduced fecal content of streptococci. S. faecium given in the water (.5, 2.5, or 4.5 x 10 CFU/pig/d) slightly increased the CFU of streptococci in the feces. Giving S. faecillm in the water or antibiotics in the feed did not reduce fecal content of coliform bacteria. Antibiotic feeding improved feed intake, growth rate, and efficiency of gain when compared to the untreated control. Pigs given the highest level of S. faecium addition to the water (i.e., 4.5 x 10^9 had performance that was intermediate to that of the untreated control and positive control. In experiment 2, dosages of S. faecium were spread further apart. Treatments were: 1) untreated negative control; 2,3, and 4) 5 x 107, 5 X 109, and 5 x 1011 CFU of S. faecium/pig/d; and 5) antibiotic-fed positive control. Streptococci content of the feces was increased by giving S. faecillm in the water. However, total coliform content was not affected by giving S. faecium or antibiotics. Antibiotic feeding improved rate of gain, feed intake, and efficiency of gain, but giving S. faecium did not improve performance of pigs compared to those given the untreated control.; 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; Streptococcus faecium; Probiotics; Antibiotics; Performance; Weanling pig

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DOSE-RESPONSE OF WEANLING PIGS TO *STREPTOCOCCUS FAECIUM*

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Summary

Two 5-wk experiments, using a total of 270 pigs (avg initial wt of 16.1 and 13.1 lb), were conducted to determine the dose-response relationship between *Streptococcus faecium* additions to drinking water and performance of newly weaned pigs. In experiment 1, treatments were: 1) untreated control; 2, 3, and 4) .5, 2.5, and 4.5 × 10^9 CFU of *S. faecium*/pig/d; 5) antibiotic-fed positive control (CSP250 and $CuSO_4$). Bacterial content of feces collected from the pigs on d 7, 14, and 21 indicated that antibiotic feeding greatly reduced fecal content of streptococci. *S. faecium* given in the water (.5, 2.5, or 4.5 × 10^9 CFU/pig/d) slightly increased the CFU of streptococci in the feces. Giving *S. faecium* in the water or antibiotics in the feed did not reduce fecal content of coliform bacteria. Antibiotic feeding improved feed intake, growth rate, and efficiency of gain when compared to the untreated control. Pigs given the highest level of *S. faecium* addition to the water (i.e., 4.5 × 10^9) had performance that was intermediate to that of the untreated control and positive control. In experiment 2, dosages of *S. faecium* were spread further apart. Treatments were: 1) untreated negative control; 2,3, and 4) 5 × 10^7, 5 × 10^9, and 5 × 10^{11} CFU of *S. faecium*/pig/d; and 5) antibiotic-fed positive control. Streptococci content of the feces was increased by giving *S. faecium* in the water. However, total coliform content was not affected by giving *S. faecium* or antibiotics. Antibiotic feeding improved rate of gain, feed intake, and efficiency of gain, but giving *S. faecium* did not improve performance of pigs compared to those given the untreated control.

(Key Words: *Streptococcus faecium*, Probiotics, Antibiotics, Performance, Weanling Pig.)

Introduction

Feeding antibiotics has resulted in consistent improvements in growth performance of pigs for more than 30 years. Because of growing concern about the use of antibiotics as feed additives, some scientists are suggesting that microbial cultures (probiotics) might be used as an alternative. The objective of this experiment was to determine if a *S. faecium* culture could replace antibiotics for nursery-age pigs.

Experimental Procedures

A total of 270 weanling pigs was used in two 35-d growth assays. A powdered form of probiotic (*S. faecium* M74[1]) was mixed into water and given to pigs via water medicators, in

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[1]Syntabac®, Syntex Animal Health, Inc., West Des Moines, IA.

a commercial-type nursery environment. Other treatments were a negative control (tap water) and a positive control (tap water and medicated feed[2]). Diet composition is given in Table 1.

Table 1. Diet Composition

Ingredient	Amount, % Phase I (d 0 to 7)	Phase II (d 7 to 21)	Phase III (d 21 to 35)
Corn	26.30	49.10	62.35
Soybean meal (48%)	21.70	21.60	26.30
Dried whey	20.00	20.00	5.00
Dried skim milk	20.00	--	--
Fish meal	--	4.00	--
Soybean oil	10.00	3.00	3.00
Monocalcium phosphate	1.15	1.15	1.50
Limestone	.40	.60	1.00
Salt	--	.10	.40
Vitamins and minerals	.35	.35	.35
Lysine-HCl	.10	.10	.10
CSP-250 and $CuSO_4$[a]	--	--	--
Total	100	100	100

[a]Supplied .11 g chlortetracycline, .11 g sulfathiazole, .06 g penicillin, and 250 mg Cu per kg of diet in the positive control.

In experiment 1, 120 weanling pigs (16.1 lb avg initial wt) were used. Pigs were allotted to pens based on weight, sex, and ancestry and randomly assigned to one of five treatments. Feed intake (ADFI), rate of gain (ADG), and feed/gain (F/G) were measured weekly and summarized to d 7, 14, 21, and 35. Feed and water were supplied ad libitum during the experiment. The *S. faecium* treatments were .5, 2.5, and 4.5 $\times$ 10^9 colony forming units (CFU)/pig/d.

Fecal scores were made daily. The scoring system was: 1 = all four pigs constipated, 2 = two of the pigs constipated, 3 = all pigs normal with semi-solid feces, 4 = one pig with diarrhea, 5 = two pigs with diarrhea, 6 = three pigs with diarrhea, and 7 = all four pigs with diarrhea. For statistical analyses, scores from d 6, 7, and 8; d 13, 14, and 15; d 20, 21, and 22; and d 34, 35, and 36 were averaged and used as the scores for d 7, 14, 21, and 35, respectively. Fecal samples were collected on d 7, 14, and 35. Colony forming units of coliform bacteria were determined using standard microbiological procedures and VRB medium. Also, CFU of streptococci were determined using Slanetz-Bartley medium.

[2]Key CSP250 Pak10®, CSP250, Fourth & Pomeroy Assoc., Inc., Clay Center, KS.

In experiment 2, 150 weanling pigs (13.1 lb avg initial wt) were used. Six pigs were housed per pen. Feed intake, ADG, and F/G were measured weekly and summarized to d 7, 14, 21, and 35. Feed and water were supplied ad libitum. The *S. faecium* treatments were 5×10^6, 5×10^9, and 5×10^{11} CFU/pig/d. The negative and positive controls were the same as experiment 1.

Fecal scores were made on d 6, 7, and 8; d 13, 14, and 15; d 20, 21, and 22; and on d 34. The scoring system was: 1 = one pig with diarrhea, 2 = two pigs with diarrhea, 3 = three pigs with diarrhea, 4 = four pigs with diarrhea, 5 = five pigs with diarrhea, and 6 = six pigs with diarrhea. Fecal samples were collected on d 20, and CFU of coliform and streptococci were determined as in experiment 1.

Results and Discussion

Experiment 1. Analyses of fecal samples collected at d 7 indicated that CFU of streptococci were reduced ($P<.03$) with antibiotic feeding (Table 2). That response was consistent at d 14 and d 35. The effect of antibiotic feeding on CFU of coliform was not consistent. When d 7, d 14, and d 35 results are evaluated concurrently, it appears that fecal content of streptococci was increased slightly when probiotic was given in the water. However, as with antibiotic feeding, no consistent effect on fecal coliform numbers was apparent. For the first 7 d of the experiment, ADG ($P<.11$), ADFI ($P<.12$), and F/G ($P<.10$) were improved for pigs fed antibiotics compared to pigs given the negative control treatment (Table 3). Fecal scores were greater ($P<.05$) for pigs given the control treatment, indicating a lower incidence of diarrhea in antibiotic-fed pigs. Pigs given the highest level of probiotic treatment (4.5×10^9) were intermediate to the negative control and antibiotic-fed pigs in performance and consistency of feces. At d 14 and 35, the same trends were present as observed at d 7.

Experiment 2. Fecal content of streptococci was increased ($P<.05$) with addition of *S. faecium* to the water (Table 4). Antibiotic feeding reduced fecal content of streptococci ($P<.05$). However, the antibiotic and *S. faecium* treatments did not reduce CFU of coliform in the feces ($P>.22$).

Fecal scores were lower ($P<.05$) for pigs given the antibiotic treatment than for pigs given the *S. faecium* treatments at d 7 (Table 5). Scores were higher for pigs fed the unmedicated control than for pigs fed the antibiotic treatment on d 14, 21, and 35, and fecal scores of pigs given the *S. faecium* treatments tended to be intermediate.

Throughout the experiment, ADG, and ADFI of antibiotic-fed pigs were greater than those of pigs given the negative control. Pigs fed antibiotics also gained faster and were more efficient than pigs given probiotic.

In conclusion, giving *S. faecium* to weanling pigs via water medicators did affect fecal content of the organism. However, at dosages ranging from 5×10^7 to 5×10^{11} CFU/pig/d, no consistent effect on ADG, ADFI, or F/G was noted. Alternatively, feeding antibiotics (CSP250 and $CuSO_4$) was effective as a means to increase performance of nursery-age pigs.

Table 2. **Effect of *Streptococcus faecium* on Bacterial Content of Feces (Exp. 1)**[a]

Item	Untreated control	CFU of *S. faecium*/pig/d (× 10^9) .5	2.5	4.5	Antibiotics (CSP250 + $CuSO_4$)	CV
Day 7						
Streptococci[bc]	8.10	8.51	8.52	7.97	6.56	13.6
Coliform[de]	5.92	6.10	5.28	6.06	6.91	17.6
Day 14						
Streptococci[f]	8.92	8.91	8.66	9.20	7.28	12.0
Coliform[g]	7.06	6.15	6.12	6.61	6.23	19.7
Day 35						
Streptococci[h]	7.58	8.17	7.92	7.99	5.46	11.4
Coliform[i]	5.52	5.58	5.11	5.77	6.15	20.1

[a]Log_{10} transformed data.
[b]Colony forming units of streptococci / g feces (× 10^6).
[c]Control vs antibiotics ($P<.03$); probiotic vs antibiotics ($P<.003$).
[d]Colony forming units of coliform bacteria / g feces (× 10^6).
[e]Control vs antibiotics ($P<.13$); probiotic vs antibiotics ($P<.05$); probiotic quadratic ($P<.16$).
[f]Control vs antibiotics ($P<.02$); probiotic vs antibiotics ($P<.004$).
[g]No treatment effect ($P>.21$).
[h]Control vs antibiotics ($P<.001$); probiotic vs antibiotics ($P<.001$).
[i]No treatment effect ($P>.22$).

Table 3. Effect of *Streptococcus faecium* on Performance of Nursery Pigs (Exp. 1)

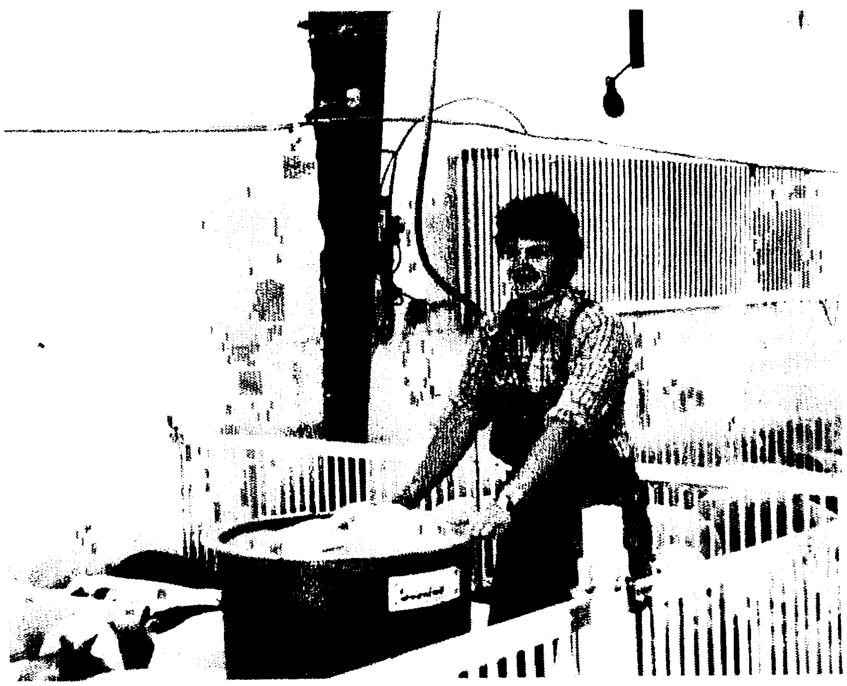
Item	Untreated control	CFU of *S. faecium*/pig/d ($\times 10^9$) .5	2.5	4.5	Antibiotics (CSP250 + $CuSO_4$)	CV[a]
Day 0 to 7						
Fecal score[bd]	4.7	4.3	4.4	4.5	3.7	7.4
ADG, lb[d]	.27	.29	.24	.33	.39	34.6
ADFI, lb[d]	.42	.41	.40	.43	.49	16.5
F/G[ce]	1.52	1.44	1.40	1.30	1.23	25.5
Day 0 to 14						
Fecal score[cd]	5.5	5.5	6.0	5.4	4.8	6.7
ADG, lb	.34	.33	.28	.35	.39	28.4
ADFI, lb[d]	.59	.55	.56	.65	.67	14.6
F/G	1.76	1.69	1.97	1.88	1.71	23.3
Day 0 to 21						
Fecal score	4.2	4.1	4.4	4.1	4.3	8.1
ADG, lb[f]	.54	.57	.48	.60	.57	16.1
ADFI, lb[cdf]	.86	.83	.76	.93	.96	10.5
F/G[f]	1.85	1.46	1.59	1.55	1.68	15.7
Day 0 to 35						
Fecal score	3.3	3.3	3.2	3.1	3.1	4.2
ADG, lb[f]	.86	.84	.77	.87	.89	9.6
ADFI, lb[df]	1.37	1.32	1.24	1.40	1.62	7.6
F/G	1.60	1.56	1.62	1.61	1.82	9.5

[a]CV for fecal scores is for square root transformed data, on a scale of 1 to 7.
[b]Control vs antibiotic ($P<.05$).
[c]Control vs antibiotic ($P<.10$).
[d]Probiotic vs antibiotic ($P<.05$).
[e]Probiotic vs antibiotic ($P<.10$).
[f]Probiotic quadratic ($P<.05$).

Table 4. **Effect of *Streptococcus faecium* on Bacterial Content of Feces (Exp. 2)**[a]

Item	Untreated control	CFU of *S. faecium*/pig/d 5×10^7	5×10^9	5×10^{11}	Antibiotics (CSP250 + $CuSO_4$)	CV
Streptococci[bc]	4.96	4.40	5.16	7.59	4.18	9.4
Coliform bacteria[de]	7.34	6.34	6.02	7.51	6.97	18.9

[a]Log_{10} transformed data.
[b]Colony forming units of streptococci / g feces ($\times 10^6$).
[c]Control vs antibiotics (P<.03); probiotic vs antibiotics (P<.001).
[d]Colony forming units of coliform bacteria / g feces ($\times 10^6$).
[e]No treatment effect (P>.22).



Dianna Reves, farrowing house manager, checks feeders in the grower unit.

Table 5. **Effect of *Streptococcus faecium* on Performance of Nursery Pigs (Exp. 2)**

Item	Untreated control	CFU of *S. faecium*/pig/d: 5×10^7	5×10^9	5×10^{11}	Antibiotics (CSP250 + $CuSO_4$)	CV[a]
Day 0 to 7						
Fecal score[be]	1.4	1.5	1.5	1.4	1.3	18.6
ADG, lb[ce]	.31	.28	.23	.30	.43	20.3
ADFI, lb[ce]	.31	.31	.27	.32	.38	16.2
F/G[e]	1.01	1.10	1.19	1.09	.87	12.1
Day 0 to 14						
Fecal score[cegh]	1.8	1.7	1.5	1.4	1.4	15.8
ADG, lb[ce]	.36	.33	.31	.33	.48	21.7
ADFI, lb[ce]	.57	.51	.52	.55	.68	14.1
F/G	1.60	1.54	1.76	1.81	1.45	18.9
Day 0 to 21						
Fecal score	1.6	1.6	1.4	1.5	1.5	21.1
ADG, lb[ce]	.54	.50	.49	.50	.66	12.0
ADFI, lb[ce]	.73	.69	.66	.68	.87	10.2
F/G	1.37	1.36	1.37	1.36	1.33	8.0
Day 0 to 35						
Fecal score[cf]	1.6	1.6	1.5	1.4	1.3	26.0
ADG, lb[ce]	.71	.66	.66	.69	.91	9.2
ADFI, lb[ce]	1.10	1.03	1.00	1.04	1.29	8.2
F/G[ce]	1.55	1.56	1.53	1.53	1.42	4.4

[a]CV for fecal scores is for square root transformed data.
[b]On a scale of 1 to 6.
[c]Control vs antibiotic (P<.05).
[d]Control vs antibiotic (P<.10).
[e]Probiotic vs antibiotic (P<.05).
[f]Probiotic vs antibiotic (P<.10).
[g]Control vs probiotic (P<.05).
[h]Probiotic linear (P<.05).