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The effect of Bacillus probiotic on growth performance and fecal consistency of growing-finishing pigs

Abstract

A total of 1,099 pigs (PIC 1050 Ã— 337; initially 75 lb) were used in a 104-d study to determine the influence of a Bacillus product and diet type on growth performance, carcass traits, fecal consistency, and pen cleaning time in growing-finishing pigs raised under commercial conditions. Pens of pigs were balanced by initial weight and randomly allotted to 1 of 6 dietary treatments in a completely randomized design with 26 to 27 pigs per pen and 7 replications per treatment. Treatments were arranged as a 3 Ã— 2 factorial with main effects of Bacillus product (0, 1x, or 10x) and diet type (corn-soybean meal or a by-product diet with 30% dried distillers grains with solubles [DDGS] and 20% bakery). The dose of Bacillus in the diet was approximately 200 million cfu/g feed for the 1x level and 2 billion cfu/g feed for the 10x level. Fecal consis- tency and manure buildup in each pen was scored at the end of the trial by 3 observers with the average value per pen used for analysis. Time required to wash each individual pen was also recorded. Overall (d 0 to 104), no differences were found in growth performance or carcass composition for pigs fed the Bacillus product; however, pigs fed the 1x level of Bacillus tended (quadratic, P = 0.10) to have the lowest ADG. Manure texture score tended to increase (linear, P = 0.07) as Bacillus dose increased, indicating that pigs fed the Bacillus product had firmer stools. For diet formulation, pigs fed the diet containing by-prod- ucts had increased (P = 0.01) ADFI compared with pigs fed the corn-soybean meal diet. With no difference in ADG, feed efficiency was poorer (P < 0.01) for pigs fed by-product diets. Pens that contained pigs fed by-product diets required more (P < 0.01) time to wash, which appeared to be the result of looser manure texture (P = 0.09) and increased (P = 0.08) manure buildup in pens where pigs were fed by-product-based diets. The Bacillus product tested did not improve growth performance, but altered fecal consistency and barn wash time.; Swine Day, Manhattan, KS, November 17, 2011

Keywords

Swine Day, 2011; Kansas Agricultural Experiment Station contribution; no. 12-064-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1056; Swine; Bacillus; By-products; Fecal consistency; Finishing pig; Wash time

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The Effect of *Bacillus* Probiotic on Growth Performance and Fecal Consistency of Growing-Finishing Pigs[1]

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Summary

A total of 1,099 pigs (PIC 1050 × 337; initially 75 lb) were used in a 104-d study to determine the influence of a *Bacillus* product and diet type on growth performance, carcass traits, fecal consistency, and pen cleaning time in growing-finishing pigs raised under commercial conditions. Pens of pigs were balanced by initial weight and randomly allotted to 1 of 6 dietary treatments in a completely randomized design with 26 to 27 pigs per pen and 7 replications per treatment. Treatments were arranged as a 3 × 2 factorial with main effects of *Bacillus* product (0, 1x, or 10x) and diet type (corn-soybean meal or a by-product diet with 30% dried distillers grains with solubles [DDGS] and 20% bakery). The dose of *Bacillus* in the diet was approximately 200 million cfu/g feed for the 1x level and 2 billion cfu/g feed for the 10x level. Fecal consistency and manure buildup in each pen was scored at the end of the trial by 3 observers with the average value per pen used for analysis. Time required to wash each individual pen was also recorded.

Overall (d 0 to 104), no differences were found in growth performance or carcass composition for pigs fed the *Bacillus* product; however, pigs fed the 1x level of *Bacillus* tended (quadratic, $P = 0.10$) to have the lowest ADG. Manure texture score tended to increase (linear, $P = 0.07$) as *Bacillus* dose increased, indicating that pigs fed the *Bacillus* product had firmer stools. For diet formulation, pigs fed the diet containing by-products had increased ($P = 0.01$) ADFI compared with pigs fed the corn-soybean meal diet. With no difference in ADG, feed efficiency was poorer ($P < 0.01$) for pigs fed by-product diets. Pens that contained pigs fed by-product diets required more ($P < 0.01$) time to wash, which appeared to be the result of looser manure texture ($P = 0.09$) and increased ($P = 0.08$) manure buildup in pens where pigs were fed by-product-based diets. The *Bacillus* product tested did not improve growth performance, but altered fecal consistency and barn wash time.

Key words: *Bacillus*, by-products, fecal consistency, finishing pig, wash time

Introduction

Probiotic bacteria have been promoted to improve growth performance and as an alternative method of preventing gastrointestinal disease in several species. One theory to explain the mechanism of action is that nonpathogenic *Bacillus* supplements compete

[1] Appreciation is expressed to New Horizon Farms for use of pigs and facilities; to Richard Brobjorg, Scott Heidebrink, and Marty Heintz for technical assistance; and to Direct Biologicals, Inc. (Crofton, NE) for providing *Bacillus* product and partial financial assistance.

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for pathogenic bacterial binding sites, which leads to a reduction in the incidence of diarrhea. Supplemental feeding of *Bacillus spp.* bacteria also has been hypothesized to alter fecal consistency, which may reduce manure buildup and facility wash time.

Diet composition has changed dramatically for most swine farms in the United States in the last few years. Alternative ingredients such as DDGS or bakery meal have increased in the diet, which may alter the response to products such as *Bacillus*. Reports also indicate that including these by-products in diets leads to increased manure volume and increased barn wash times. Thus, the objective of this experiment was to investigate the effect of a *Bacillus* product on growth performance and carcass composition of finishing pigs fed corn-soy or by-product (DDGS and bakery meal) diets and the resulting effects on fecal consistency and pen wash time.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at a commercial research-finishing barn in southwestern Minnesota. The barns were naturally ventilated and double-curtain-sided. Pens had completely slatted flooring and deep pits for manure storage. Each pen was equipped with a 5-hole stainless steel dry self-feeder and a cup waterer for ad libitum access to feed and water. Daily feed additions to each pen were accomplished through a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of providing and measuring feed amounts for individual pens.

A total of 1,099 pigs (PIC 1050 × 337) with an initial body weight of 75 lb were used in a 104-d study. A similar number of barrows and gilts were placed in each pen with 26 to 27 pigs per pen, with 7 pens per treatment. Pens of pigs were allotted to 1 of 6 treatments in a completely randomized design while balancing for body weight. Treatments were arranged in a 3 × 2 factorial with main effects of *Bacillus* product dose (0, 1x, or 10x; Sporzyme, Direct Biologicals, Inc., Crofton, NE) and diet formulation strategy (corn-soybean meal or by-product diet). The dietary *Bacillus* dose was approximately 200 million cfu/g feed for the 1x level and 2 billion cfu/g feed for the 10x level. The diets contained 30% DDGS until the last phase before market, when they contained 20%, and these diets used 20% bakery only in the first phase of the study (from 75 to 120 lb). Diets were fed in 5 phases with phases from 75 to 120 lb, 120 to 160 lb, 160 to 200 lb, 200 to 240 lb, and 240 lb to market (Tables 1 and 2).

Pens of pigs were weighed and feed disappearance was recorded at d 14, 29, 43, 65, 77, and 104 to determine ADG, ADFI, and F/G. At the end of the experiment, pigs were individually tattooed by pen number to allow for carcass data collection at the packing plant and data retrieval by pen. Pigs were transported to JBS Swift and Company (Worthington, MN) for processing. Standard carcass criteria of loin and backfat depth, HCW, percentage lean, and percentage yield were collected.

To measure fecal consistency, each pen was scored for manure texture and manure buildup at the end of the trial by 3 observers. The 3 scores were averaged to determine a mean score, which was used for analysis. Manure textures were categorized in 3 categories as firm, medium, and loose with the score of 1, 0, and -1, respectively. Manure buildup was given a value of 1 for visual manure buildup and -1 for no visual manure

buildup. The time required to wash each individual pen was measured to determine whether the diet or supplement influenced wash time.

The experimental data were analyzed using the MIXED procedure of SAS (SAS institute, Inc., Cary, NC). Treatments were arranged in a 2 × 3 factorial and data were analyzed for the main effects of diet type, linear and quadratic effect of *Bacillus,* and any interactions between linear and quadratic effects of *Bacillus* level and diet type. Pen was the experimental unit for all data analysis, and significance and tendencies were set at $P < 0.05$ and $P < 0.10$, respectively.

Results and Discussion

No linear or quadratic interactions were detected between increasing *Bacillus* dosage and diet type ($P > 0.13$; Table 3), so the main effects of *Bacillus* dosage and diet type are presented (Table 4). Overall (d 0 to 104), no differences were measured in growth performance or carcass composition for pigs fed different levels of *Bacillus* product; however, pigs fed the 1x level of *Bacillus* tended (quadratic, $P = 0.10$) to have the lowest ADG. Due to this tendency, carcass value was affected in a quadratic manner, with pigs fed the 1x *Bacillus* having the highest price and premium and lowest sort loss. Manure texture score tended to increase (linear, $P = 0.07$) as *Bacillus* increased, suggesting that pigs fed the *Bacillus* product had firmer stools. Wash time was numerically reduced (linear, $P = 0.16$) as *Bacillus* level increased in the diet. The 50-sec difference in wash time per pen would equate to a 40-min reduction in wash time on a 48-pen barn for pigs fed the 10x level of the *Bacillus* product compared with the control.

For diet formulation, pigs fed the by-product diet had increased ($P = 0.01$) ADFI compared with pigs fed the corn-soy diet, but with no difference in ADG, feed efficiency was poorer ($P < 0.01$) for pigs fed the by-product diets. Pigs fed the by-product diets tended ($P = 0.06$) to have decreased backfat than pigs fed corn-soybean meal diets, which led to a tendency ($P = 0.09$) for greater carcass premium. No differences occurred in any other carcass criteria. Manure texture tended to be looser ($P = 0.09$) with more manure buildup ($P = 0.08$) in pens where pigs were fed by-product diets compared with pens with corn/soybean meal diets. Pens where by-product diets were fed required longer wash time ($P < 0.01$). Wash time was 2.4 min longer per pen where pigs were fed the by-product diets compared with pens where pigs were fed corn-soybean meal diets. When extrapolated over a 48-pen barn, feeding the high-by-product diets would increase wash time per barn by just less than 2 h (1 h and 53 min) compared with a barn where corn-soybean meal diets were fed.

Table 1. Composition of Phase 1, Phase 2, and Phase 3 diets[1]

	Phase 1		Phase 2		Phase 3	
Item	Corn-soy	By-products	Corn-soy	By-products	Corn-soy	By-products
Ingredient, %						
Corn	75.45	32.30	79.35	55.00	82.40	57.85
Soybean meal, 46.5% CP	22.05	15.35	18.35	12.85	15.45	10.05
Bakery by-product	---	20.00	---	---	---	---
DDGS[2]	---	30.00	---	30.00	---	30.00
Monocalcium P, 21% P	0.55	---	0.40	---	0.325	---
Limestone	0.95	1.275	0.975	1.2	0.95	1.15
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin-trace mineral premix	0.10	0.10	0.10	0.10	0.09	0.09
L-Threonine	0.07	---	0.045	---	0.035	---
L-Lysine sulfate	0.45	0.61	0.415	0.52	0.38	0.48
DL-Methionine	0.04	---	0.02	---	0.01	---
Phytase[3]	0.01	0.005	0.01	0.005	0.01	0.005
Bacillus[4]	---	---	---	---	---	---
Total	100	100	100	100	100	100
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lysine	0.98	0.98	0.87	0.87	0.78	0.78
Isoleucine:lysine	62	68	63	70	64	72
Leucine:lysine	144	177	152	197	161	212
Methionine:lysine	29	32	29	34	29	37
Met & Cys:lysine	56	66	57	70	59	75
Threonine:lysine	62	62	61	65	62	67
Tryptophan:lysine	17	17	17	17	17	17
Valine:lysine	71	82	73	86	76	90
Total lysine, %	1.09	1.14	0.97	1.03	0.87	0.93
ME, kcal/lb	1,519	1,549	1,521	1,525	1,523	1,526
SID lysine:ME, g/Mcal	2.93	2.87	2.59	2.59	2.32	2.32
CP, %	17.1	20.7	15.6	19.2	14.5	18.1
Ca, %	0.57	0.58	0.53	0.53	0.50	0.50
P, %	0.48	0.46	0.43	0.46	0.41	0.45
Available P, %	0.28	0.28	0.25	0.27		0.27

[1] Phase 1 diet was fed from 75 to 120 lb, Phase 2 was fed from 120 to 160 lb, and Phase 3 was fed from 160 to 200 lb.
[2] Dried distillers grains with solubles.
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN).
[4] *Bacillus* (Sporzyme, Direct Biologicals, Inc., Crofton, NE) was added to the diet in place of corn to provide approximately 200 million cfu/g feed for the 1x level and 2 billion cfu/g feed for the 10x level.

Table 2. Diet composition of Phase 4 and Phase 5[1]

	Phase 4		Phase 5	
Item	Corn-soy	By-products	Corn-soy	By-products
Ingredient, %				
Corn	85.40	60.85	87.95	71.70
Soybean meal, 46.5% CP	12.60	7.20	10.10	6.45
Bakery by-product	---	---	---	---
DDGS[2]	---	30.00	---	20.00
Monocalcium P, 21% P	0.30	---	0.25	---
Limestone	0.90	1.10	0.90	1.05
Salt	0.35	0.35	0.35	0.35
Vitamin-trace mineral premix	0.09	0.09	0.09	0.09
L-Threonine	0.033	---	0.03	---
L-Lysine sulfate	0.345	0.445	0.31	0.38
DL-Methionine	0.01	0.005	0.01	0.005
Phytase[3]	---	---	---	---
Bacillus[4]	---	---	---	---
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible (SID) amino acids, %				
Lysine	0.69	0.69	0.61	0.61
Isoleucine:lysine	65	75	67	74
Leucine:lysine	172	230	186	229
Methionine:lysine	30	40	32	39
Met & Cys:lysine	62	81	67	81
Threonine:lysine	64	71	66	70
Tryptophan:lysine	17	17	17	17
Valine:lysine	79	95	82	94
Total lysine, %	0.78	0.83	0.69	0.73
ME, kcal/lb	1,525	1,528	1,526	1,528
SID lysine:ME, g/Mcal	2.05	2.05	1.81	1.81
CP, %	13.4	17.0	12.4	14.8
Ca, %	0.47	0.47	0.45	0.45
P, %	0.39	0.43	0.37	0.39
Available P, %	0.22	0.27	0.21	0.21

[1] Phase 4 diet was fed from 200 to 240 lb and the Phase 5 diet was fed from 240 lb to market.
[2] Dried distillers grains with solubles.
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN).
[3,4] *Bacillus* (Sporzyme, Direct Biologicals, Inc., Crofton, NE) was added to the diet in place of corn to provide approximately 200 million cfu/g feed for the 1x level and 2 billion cfu/g feed for the 10x level.

Table 3. Interactive effects of probiotic (*Bacillus* product) on growth performance and fecal consistency of growing-finishing pigs[1]

	Corn-soy			By-products[2]				Probability, $P <$	
								Bacillus × diet type	
Bacillus[3]	None	1x	10x	None	1x	10x	SEM	Linear	Quadratic
d 0 to 104									
ADG, lb	2.21	2.14	2.15	2.18	2.16	2.19	0.022	0.13	0.89
ADFI, lb	5.71	5.50	5.57	5.83	5.73	5.82	0.096	0.48	0.76
F/G	2.58	2.56	2.59	2.67	2.65	2.66	0.028	0.76	0.72
Pig weight, lb									
d 0	75.3	75.1	75.0	75.5	74.5	74.9	2.38	0.93	0.88
d 104	301.9	294.5	294.9	298.7	297.0	299.6	4.23	0.35	0.81
Carcass measurements									
HCW, lb	223.8	219.3	220.8	222.2	218.3	222.6	3.33	0.62	0.85
Yield, %	77.2	77.4	77.8	76.5	77.1	77.4	0.005	0.79	0.69
Backfat depth, in.	0.72	0.71	0.71	0.70	0.66	0.69	0.018	0.91	0.38
Loin depth, in.	2.84	2.84	2.89	2.85	2.84	2.85	0.023	0.30	0.83
Lean, %	56.4	56.6	56.7	56.7	57.3	56.8	0.303	0.80	0.42
Carcass values									
Price, $/cwt	93.5	95.1	94.2	94.9	96.0	93.4	0.722	0.14	0.63
Premium, $/cwt	2.85	3.14	2.93	3.12	3.69	3.04	0.217	0.70	0.34
Sort loss, $/cwt	-3.51	-2.21	-2.88	-2.45	-1.90	-3.83	0.691	0.15	0.83
Manure score									
Texture[4]	-0.09	0.00	0.09	-0.48	-0.19	-0.05	0.167	0.47	0.81
Buildup[5]	0.05	-0.24	-0.62	-0.05	0.43	0.05	0.281	0.18	0.44
Wash time, min/pen	9.8	8.9	9.2	11.8	12.4	10.7	0.6	0.66	0.09

[1]A total of 1,099 finishing pigs (initial BW 75 lb) were used in a 104-d trial. Pigs were randomly allotted to 1 of 6 dietary treatments with 26 or 27 pigs/pen and 7 pens per treatment.
[2]By-product diets contained 30% dried distillers grains with solubles (DDGS) until the last phase before market, when they contained 20%, and these diets used 20% bakery only in the first phase of trial.
[3]The *Bacillus* that was used for this trial was approximately 200 million cfu/g feed (1 lb/ton) for the 1x level and 2 billion cfu/g feed (3.5 lb/ton) for the 10x level.
[4]Manure textures were categorized in 3 categories as firm, medium, and loose with the score of 1, 0, and -1.
[5]Manure buildup was given value of 1 for visual manure buildup and -1 for no visual manure buildup.

Table 4. Main effect of probiotic (*Bacillus* product) on growth performance and fecal consistency of growing-finishing pigs[1]

	Bacillus level[2]			Diet type			Probability, *P* <		
							Bacillus		
Item	None	1x	10x	Corn-soy	By-products[3]	SEM	Linear	Quadratic	Diet type
d 0 to 104									
ADG, lb	2.20	2.15	2.17	2.17	2.18	0.022	0.20	0.10	0.56
ADFI, lb	5.77	5.61	5.69	5.59	5.79	0.096	0.43	0.17	<0.01
F/G	2.63	2.61	2.62	2.58	2.66	0.028	0.96	0.53	<0.01
Pig weight, lb									
d 0	75.40	74.80	74.95	75.13	74.97	2.38	0.84	0.86	0.93
d 104	300.3	295.8	297.3	297.1	298.4	4.23	0.48	0.42	0.70
Carcass characteristics									
HCW, lb	223.0	218.8	221.7	221.3	221.0	3.33	0.70	0.22	0.92
Yield, %	76.9	77.3	77.6	77.5	77.0	0.005	0.13	0.92	0.27
Backfat depth, in.	0.71	0.68	0.70	0.71	0.68	0.018	0.61	0.16	0.06
Loin depth, in.	2.84	2.84	2.87	2.86	2.84	0.023	0.27	0.46	0.55
Lean, %	56.5	56.9	56.8	56.5	56.9	0.303	0.45	0.24	0.12
Carcass values									
Price, $/cwt	94.2	95.5	93.8	94.3	94.7	0.722	0.60	0.02	0.45
Premium, $/cwt	2.99	3.41	2.99	2.97	3.28	0.217	0.99	0.03	0.09
Sort loss, $/cwt	-2.98	-2.06	-3.36	-2.87	-2.73	0.691	0.59	0.07	0.80
Manure score									
Texture[4]	-0.29	-0.10	0.02	0.00	-0.24	0.167	0.07	0.81	0.09
Buildup[5]	0.00	0.10	-0.29	-0.27	0.14	0.281	0.31	0.33	0.08
Wash time, min/pen	10.8	10.6	9.9	9.3	11.6	0.6	0.16	0.57	<0.01

[1] A total of 1,099 finishing pigs (initial BW 75 lb) were used in a 104-d trial. Pigs were randomly allotted to 1 of 6 dietary treatments with 26 or 27 pigs/pen and 7 pens per treatment.
[2] The *Bacillus* that was used for this trial was approximately 200 million cfu/g feed (1 lb/ton) for the 1x level and 2 billion cfu/g feed (3.5 lb/ton) for the 10x level.
[3] By-product diets contained 30% dried distillers grains with solubles (DDGS) until the last phase before market, when they contained 20%, and these diets used 20% bakery only in the first phase of trial.
[4] Manure textures were categorized in 3 categories as firm, medium, and loose with the score of 1, 0, and -1.
[5] Manure buildup was given a value of 1 for visual manure buildup and -1 for no visual manure buildup.