The Effects of MicroSource S on Growth Performance, Fecal Consistency, and Postcleaning Microbial Load of Growing-Finishing Pigs[1]

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Summary

A total of 1,245 pigs (PIC 1050 × 337, initially 106 lb) were used in a 90-d study to determine the effects of MicroSource S (DSM Nutritional Products Inc., Parsippany, NJ) and diet type on growth performance, carcass traits, fecal consistency, pen cleaning time, and postcleaning microbial load 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 25 to 26 pigs per pen and 8 replications per treatment. Treatments were arranged as a 3 × 2 factorial with main effects of MicroSource S (0, 1×, or 1.3×) and diet type (corn-soybean meal or a by-product–based diet with 30% dried distillers grains with solubles [DDGS] and 15% bakery by-product). The MicroSource S dose in the diet was 147 million cfu/g feed for the 1× level and 191 million cfu/g feed for the 1.3× 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. After pens were cleaned and dried, ATP (adenosine triphosphate) testing was used to measure microbial load in each pen.

Overall (d 0 to 90), increasing MicroSource S had no effect ($P > 0.12$) on growth performance, carcass characteristics, ATP concentration, manure score, or wash time, but pigs fed 1× MicroSource S tended (quadratic, $P = 0.07$) to have the lowest carcass yield. No interactions ($P > 0.33$) were observed between MicroSource S dosage and diet type for growth performance, ATP concentration, manure score, or wash time; however, a MicroSource S × diet type interaction (quadratic, $P < 0.01$) was observed for loin depth. In pigs fed the 1× MicroSource S diet, loin depth increased when fed the by-product diet, but MicroSource S reduced loin depth in pigs fed either the corn-soybean meal or 1.3× diets. No differences occurred in ADG among pigs fed the corn-soybean meal-based diet and those fed the by-product diet. Pigs fed the by-product diet had greater ($P < 0.01$) ADFI and poorer ($P < 0.01$) F/G compared with those fed the corn-soybean meal diet. Pens of pigs fed the by-product diets required more ($P < 0.01$) time to wash, which appeared to be the result of an increase ($P = 0.08$) in manure buildup. In this trial, the 1× or 1.3× level of MicroSource S did not improve growth performance or alter fecal consistency, postcleaning microbial load, or barn wash time.

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[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 DSM Nutritional Products, Inc. (Parsippany, NJ) for providing Bacillus product and partial financial assistance.

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Key words: by-products, enzyme fecal consistency, microbial load, finishing pigs, wash time

Introduction

Probiotic bacteria have been promoted to improve growth performance and as an alternative method of preventing gastrointestinal disease in several species. Supplemental feeding of *Bacillus spp.* bacteria also has been hypothesized to alter fecal consistency due to the reduction in diarrhea incidence by its action in prevention of pathogenic bacteria at the binding site. A previous study at Kansas State University (Nitikanchana et al., 2011[4]) was conducted with increasing dietary addition of *Bacillus spp.* (0, 1×, or 10×; Sporzyme, Direct Biologicals Inc., Crofton, NE) in corn-soybean meal and by-product (DDGS and bakery meal)–based diets. Although no differences were observed in growth performance, barn wash time decreased approximately 50 sec per pen when pigs were fed the 10× *Bacillus* diet.

This experiment investigated the effect of another *Bacillus* product, MicroSource S, on growth performance and carcass composition of finishing pigs fed corn-soybean meal or by-product diets and its effects on fecal consistency, pen wash time, and postcleaning microbial load after barn closeout.

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 provided through a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of measuring feed amounts for individual pens.

A total of 1,245 pigs (PIC 1050 × 337, initially 106 lb BW) were used in a 90-d study. A similar number of barrows and gilts were placed in each pen, with 25 to 26 pigs per pen and 8 pens per treatment. Pens of pigs were allotted to 1 of 6 treatments in a completely randomized design while balancing for weight. Treatments were arranged in a 3 × 2 factorial with main effects of MicroSource S dose (0, 1×, or 1.3×) and diet type (corn-soybean meal or DDGS/bakery–based diets). The added MicroSource S dose was 147 million cfu/g feed for the 1× level and 191 million cfu/g feed for the 1.3× dose. The by-product diets contained 30% DDGS and 15% bakery by-product. From d 72 to 90, DDGS level was lowered to 20% and diets in this phase also contained 9 g/ton of Ractopamine HCl (Paylean; Elanco Animal Health, Greenfield, IN). Diets were fed in 5 phases, from 106 to 125 lb, 125 to 160 lb, 160 to 200 lb, 200 to 245 lb, and 245 lb to market (Tables 1 and 2).

Pens of pigs were weighed and feed disappearance was recorded at d 9, 26, 48, 72, and 90 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 (Worthing-

[4] Nitikanchana et al., Swine Day 2011, Report of Progress 1056, pp. 240–246.

ton, MN) for processing. Standard carcass criteria of loin and backfat depth, HCW, percentage lean, and percentage carcass yield were collected.

To measure fecal consistency, 3 people scored each pen for manure texture and buildup at the end of the trial. The scores were averaged to determine a mean score, which was used for analysis. Manure textures were categorized as firm, medium, and loose with scores of 1, 0, and -1, respectively. Manure buildup was categorized as 1 for visual manure buildup and -1 for no visual manure buildup. The time required to wash each individual pen was recorded to determine wash time.

To measure the microbial load, ATP testing was used after the barn was washed and dried. A 100 cm^2 surface area in front of the feeder and in the opposite corner facing the alley way in each pen was swabbed (PocketSwab Plus ATP Swab, Charm Sciences Inc., Lawrence, MA) and immediately tested for the presence of ATP using a luminometer.

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 MicroSource S*,* and any interactions between linear and quadratic effects of MicroSource S and diet type. Contrast coefficients for MicroSource S (0, 1×, and 1.3×) were determined for unequally spaced treatments by using the IML procedure of SAS. Hot carcass weight served as a covariate for the analysis of backfat, loin depth, and lean percentage. 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

For the overall period, no linear or quadratic interactions ($P > 0.33$; Table 3) were observed between increasing MicroSource S dosage and diet type on finishing pig growth performance. For carcass characteristics, loin depth in pigs fed the 1× *Bacillus* in the by-product diet was greater than in that of pigs fed the corn-soybean meal diet, but in the control or 1.3× dosage, loin depth decreased, resulting in a MicroSource S and diet type interaction (quadratic, $P < 0.01$). No interactions were detected ($P > 0.32$) in ATP concentration, manure score, or wash time.

For the main effect of Microsurce S dosage, no differences were observed ($P > 0.12$; Table 4) in growth performance for pigs fed increasing MicroSource S for the overall period (d 0 to 90). MicroSource S dosage did not influence carcass characteristics ($P > 0.14$), but carcass yield tended to decrease quadratically ($P = 0.07$); pigs fed 1× *Bacillus* had a lower yield than those fed the control or 1.3× *Bacillus*. Concentration of ATP, manure score, and wash time were not altered ($P > 0.13$) by MicroSource S dosage.

For diet type, pigs fed the by-product diet had greater ($P < 0.01$; Table 5) ADFI than pigs fed the corn-soybean meal diet; however, with no differences in ADG ($P = 0.30$), feed efficiency was poorer ($P < 0.01$) for pigs fed the by-product diets. Carcass characteristics did not differ between diet types, but HCW of pigs fed the corn-soybean meal diet tended to be greater ($P = 0.06$) than those fed with the by-product diet. No differences were detected ($P > 0.27$) in ATP concentration between the diet type. More manure buildup was observed ($P < 0.01$) in pens where pigs were fed by-product diets compared with pens of pigs fed corn-soybean meal diets, but manure texture was not different ($P = 0.85$) between diet types. As a result of more manure buildup, pens where by-product diets were fed required longer wash time ($P < 0.01$) than pens of pigs fed corn-soybean meal diets. Wash time was 2.7 min longer per pen where pigs were fed the by-product diets than pens fed with corn-soybean meal diets. When extrapolated over a 48-pen barn, feeding the by-product diets would increase wash time per barn by approximately 2 h (2 h and 10 min) compared with a barn where corn-soybean meal diets were fed.

In this study, increasing MicroSource S to 191 million cfu/g of feed did not improve growth performance or carcass characteristics. This result is similar to those of Nitikanchana et al. (2011[5]), who observed no improvement with increasing a different *Bacillus* enzyme to 2 billion cfu/g of feed. In that trial, pigs fed the *Bacillus* product had firmer stools, resulting in a numeric decrease in pen wash time by 50 sec per pen for pigs fed 2 billion cfu/g of feed compared with the control. The present study did not observe the difference in manure score or wash time, which may be due to the dosage of *Bacillus* with an addition of only 191 million cfu/g of feed.

The response in diet types replicated the results of Nitikanchana et al. (2011), where pigs fed with by-product diet had poorer feed efficiency due to the higher feed intake than pigs fed with corn-soybean meal diet. Also, feeding pigs the by-product diet increased manure buildup and resulted in a longer barn wash time by approximately 2 h in both trials.

MicroSource S did not affect growth performance of growing-finishing pigs or alter fecal consistency, postcleaning microbial load, or barn wash time at the 1× or 1.3× level of dietary inclusion.

[5] Nitikanchana et al., Swine Day 2011, Report of Progress 1056, pp. 240–246.

Table 1. Diet composition[1]

	Phase 1		Phase 2		Phase 3	
Item	Corn-soy	DDGS[2]/ bakery	Corn-soy	DDGS/ bakery	Corn-soy	DDGS/ bakery
Ingredient, %						
Corn	73.05	34.75	76.90	38.60	80.05	41.55
Soybean meal, 46.5% CP	24.35	18.00	20.65	14.20	17.70	11.20
Bakery by-product	---	15.00	---	15.00	---	15.00
DDGS	---	30.00	---	30.00	---	30.00
Monocalcium P, 21% P	0.60	---	0.53	---	0.45	---
Limestone	1.07	1.29	1.04	1.27	1.01	1.26
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	0.10	0.10
L-threonine	0.04	---	0.02	---	0.015	---
L-lysine sulfate	0.38	0.52	0.34	0.49	0.31	0.46
DL-methionine	0.03	---	0.01	---	---	---
Phytase[3]	0.005	0.005	0.005	0.005	0.005	0.005
MicroSource S[4]	---	---	---	---	---	---
Total	100	100	100	100	100	100
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lysine	1.00	1.00	0.89	0.89	0.80	0.80
Isoleucine:lysine	65	71	66	73	67	75
Leucine:lysine	146	181	155	193	163	206
Methionine:lysine	28	33	28	35	29	37
Met & Cys:lysine	56	62	58	65	59	69
Threonine:lysine	60	64	60	66	61	68
Tryptophan:lysine	18	18	18	18	18	18
Valine:lysine	74	84	76	88	78	91
Total lysine, %	1.12	1.14	1.00	1.05	0.90	0.95
ME, kcal/lb	1,516	1,504	1,517	1,505	1,519	1,505
SID lysine:ME, g/Mcal	2.99	3.02	2.66	2.68	2.39	2.41
CP, %	17.9	21.5	16.4	20.0	15.3	18.9
Ca, %	0.62	0.59	0.58	0.57	0.55	0.56
P, %	0.50	0.47	0.47	0.46	0.44	0.45
Available P, %	0.26	0.28	0.24	0.28	0.22	0.27

[1] Phase 1 diet was fed from 106 to 125 lb, Phase 2 was fed from 125 to 160 lb, and Phase 3 was fed from 160 to 200 lb.
[2] DDGS: dried distillers grains with solubles.
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN) provided an available P release of 0.07%.
[4] MicroSource S, DSM Nutritional Products Inc. (Parsippany, NJ) was added to the diet in place of corn to provide 147 million cfu/g feed for the 1× level and 191 cfu/g feed for the 1.3× dosage.

Table 2. Diet composition[1]

	Phase 4		Phase 5	
Item	Corn-soy	DDGS[2]/ bakery	Corn-soy	DDGS/ bakery
Ingredient, %				
Corn	82.50	44.00	75.95	45.70
Soybean meal, 46.5% CP	15.30	8.85	21.65	17.10
Bakery by-product	---	15.00	---	15.00
DDGS	---	30.00	---	20.00
Monocalcium P, 21% P	0.41	---	0.40	---
Limestone	0.99	1.24	1.00	1.15
Salt	0.35	0.35	0.35	0.35
Vitamin-trace mineral premix	0.10	0.10	0.10	0.10
L-threonine	0.015	---	0.08	0.03
L-lysine sulfate	0.29	0.44	0.35	0.46
DL-methionine	0.01	---	0.05	---
Phytase[3]	0.005	0.005	0.005	0.005
Ractopamine HCl, 9 g/lb[4]	---	---	0.05	0.05
MicroSource S[5]	---	---	---	---
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible (SID) amino acids, %				
Lysine	0.73	0.73	0.92	0.92
Isoleucine:lysine	68	76	66	70
Leucine:lysine	171	219	152	176
Methionine:lysine	30	40	32	32
Met & Cys:lysine	62	73	60	61
Threonine:lysine	63	70	66	66
Tryptophan:lysine	18	18	18	18
Valine:lysine	80	95	75	83
Total lysine, %	0.82	0.88	1.03	1.07
ME, kcal/lb	1,521	1,506	1,519	1,506
SID Lysine:ME, g/Mcal	2.18	2.20	2.75	2.77
CP, %	14.4	18.0	16.9	19.3
Ca, %	0.53	0.54	0.56	0.53
P, %	0.42	0.44	0.45	0.43
Available P, %	0.21	0.27	0.22	0.23

[1] Phase 4 diet was fed from 200 to 245 lb and Phase 5 diet was fed from 245 lb to market.
[2] DDGS: dried distillers grains with solubles.
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN) provided an available P release of 0.07%.
[4] Ractopamine HCl (Paylean; Elanco Animal Health, Greenfield, IN) was added at 9.0 g/ton.
[5] MicroSource S, DSM Nutritional Products Inc. (Parsippany, NJ) was added to the diet in place of corn to provide 147 million cfu/g feed for the 1× and 191 cfu/g feed for the 1.3× dosage, respectively.

Table 3. Interactive effects of MicroSource S on growth performance, fecal consistency, and postcleaning microbial load (ATP) of growing-finishing pigs[1]

	No MicroSource S		1× MicroSource S[2]		1.3× MicroSource S			Probability, $P<$	
								MicroSource S × diet type	
Diet type[3]	Corn-SBM	By-product	Corn-SBM	By-product	Corn-SBM	By-product	SEM	Linear	Quadratic
d 0 to 90									
ADG, lb	1.98	1.96	1.96	1.93	1.95	1.95	0.017	0.79	0.44
ADFI, lb	5.45	5.81	5.47	5.65	5.42	5.72	0.073	0.47	0.35
F/G	2.76	2.96	2.79	2.92	2.79	2.94	0.032	0.33	0.62
Initial wt, lb	106.0	106.0	106.0	106.0	106.0	106.0	1.996	0.99	1.00
Final wt, lb	282.3	280.0	279.2	276.8	279.1	278.8	2.556	0.76	0.72
Carcass measurements									
HCW, lb	208.6	204.6	204.6	203.0	207.7	203.4	2.053	0.89	0.47
Carcass yield, %	76.5	76.3	75.4	75.0	76.2	76.8	0.781	0.71	0.61
Backfat depth, in.	0.58	0.58	0.61	0.59	0.59	0.57	0.013	0.64	0.55
Loin depth, in.	2.73	2.70	2.68	2.74	2.74	2.66	0.023	0.99	<0.01
Lean, %	58.2	58.2	57.6	58.2	58.2	58.1	0.237	0.78	0.12

continued

Table 3. Interactive effects of MicroSource S on growth performance, fecal consistency, and postcleaning microbial load (ATP) of growing-finishing pigs[1]

	No MicroSource S		1× MicroSource S[2]		1.3× MicroSource S			Probability, $P<$	
								MicroSource S × diet type	
Diet type[3]	Corn-SBM	By-product	Corn-SBM	By-product	Corn-SBM	By-product	SEM	Linear	Quadratic
ATP concentration[4]									
Feeder	284,838	264,510	334,409	336,063	274,021	341,587	47,570	0.43	0.60
Corner	340,825	297,972	388,876	329,010	356,297	279,033	52,311	0.76	0.92
Average	312,831	281,241	361,643	332,537	315,159	310,310	37,415	0.77	0.79
Manure score									
Texture[5]	0.25	0.00	0.13	0.25	0.08	0.13	0.178	0.32	0.64
Buildup[6]	-0.50	0.67	-0.83	0.67	-0.33	0.92	0.235	0.71	0.53
Wash time, min/pen	6.3	8.7	6.1	8.2	6.3	9.7	0.658	0.58	0.40

[1] A total of 1,245 finishing pigs (initial BW 106 lb) were used in a 90-d trial. Pigs were randomly allotted to 1 of 6 dietary treatments with 25 or 26 pigs/pen and 8 pens per treatment. ATP: adenosine triphosphate.

[2] MicroSource S (DSM Nutritional Products Inc., Parsippany, NJ) provided approximately 147 million cfu/g feed for the 1× and 191 million cfu/g feed for the 1.3× dosage, respectively.

[3] By-product diets contained 30% dried distillers grains with solubles (DDGS) and 15% bakery by-product; DDGS was lowered to 20% in the last phase diets.

[4] ATP testing was used to measure ATP concentration as an indicator of microbial load after barn was washed and dried. Floor was swabbed in front of the feeder and in the opposite corner facing the alleyway.

[5] Manure textures were categorized as firm, medium, or loose with scores of 1, 0, and -1, respectively.

[6] Manure buildup was given value of 1 for visual manure buildup and -1 for no visual manure buildup.

Table 4. Main effects of MicroSource S on growth performance, fecal consistency, and postcleaning microbial load (ATP) in growing-finishing pigs[1]

	MicroSource S[2]				Probability, *P*<	
	None	1×	1.3×	SEM	Linear	Quadratic
d 0 to 90						
ADG, lb	1.97	1.95	1.95	0.012	0.12	0.81
ADFI, lb	5.63	5.56	5.57	0.052	0.33	0.73
F/G	2.86	2.86	2.86	0.023	0.93	0.86
Initial wt, lb	106.0	106.0	106.0	1.411	1.00	1.00
Final wt, lb	281.1	278.0	279.0	1.808	0.28	0.53
Carcass measurements						
HCW, lb	206.6	203.8	205.6	1.452	0.62	0.21
Carcass yield, %	76.4	75.2	76.5	0.541	0.97	0.07
Backfat depth, in.	0.58	0.60	0.58	0.009	0.56	0.14
Loin depth, in.	2.71	2.71	2.70	0.016	0.58	0.81
Lean, %	58.2	57.9	58.1	0.164	0.54	0.20
ATP concentration[3]						
Feeder	274,674	335,236	307,804	33,637	0.33	0.42
Corner	319,398	358,943	317,665	36,989	0.82	0.39
Average	297,036	347,090	312,735	26,456	0.44	0.27
Manure score						
Texture[4]	0.13	0.19	0.10	0.126	0.98	0.63
Buildup[5]	0.08	-0.08	0.29	0.166	0.65	0.13
Wash time, min/pen	7.5	7.1	8.0	0.465	0.73	0.21

[1] A total of 1,245 finishing pigs (initial BW 106 lb) were used in a 90-d trial. Pigs were randomly allotted to 1 of 6 dietary treatments with 25 or 26 pigs/pen and 8 pens per treatment. ATP: adenosine triphosphate.
[2] The *Bacillus* that was used for this trial was approximately 147 million cfu/g feed for the 1× level and 191million cfu/g feed for the 1.3× level.
[3] ATP testing was used to measure ATP concentration as an indicator of microbial load after barn was washed and dried. Floor was swabbed in front of the feeder and in the opposite corner facing the alleyway.
[4] Manure textures were categorized as firm, medium, or loose with scores of 1, 0, and -1, respectively.
[5] Manure buildup was given the value of 1 for visual manure buildup and -1 for no visual manure buildup.

Table 5. Main effect of diet type on growth performance, fecal consistency, and postcleaning microbial load in growing-finishing pigs[1]

	Diet type			
	Corn-soybean meal	By-product[2]	SEM	Probability, *P*<
d 0 to 90				
ADG, lb	1.96	1.95	0.010	0.30
ADF, lb	5.45	5.73	0.042	<0.01
F/G	2.78	2.94	0.019	<0.01
Initial wt, lb	106.0	106.0	1.52	0.99
Final wt, lb	280.2	278.5	1.476	0.43
Carcass measurements				
HCW, lb	207.0	203.7	1.186	0.06
Carcass yield, %	76.0	76.0	0.448	0.96
Backfat depth, in.	0.59	0.58	0.007	0.18
Loin depth, in.	2.72	2.70	0.013	0.37
Lean, %	58.0	58.1	0.136	0.35
ATP concentration[3]				
Feeder	297,756	314,053	27,465	0.68
Corner	361,999	302,005	30,202	0.17
Average	329,878	308,029	21,602	0.48
Manure score				
Texture[4]	0.15	0.13	0.103	0.85
Buildup[5]	-0.56	0.75	0.136	<0.01
Wash time, min/pen	6.2	8.9	0.380	<0.01

[1]A total of 1,245 finishing pigs (initial BW 106 lb) were used in a 90-d trial. Pigs were randomly allotted to 1 of 6 dietary treatments with 25 or 26 pigs/pen and 8 pens per treatment.

[2] By-product diets contained 30% DDGS and 15% bakery; dried distillers grains with solubles (DDGS) were lowered to 20% in the last phase diets.

[3] ATP (adenosine triphosphate) testing was used to measure ATP concentration as an indicator of microbial load after barn was washed and dried. Floor was swabbed in front of the feeder and in the opposite corner facing the alleyway.

[4] Manure textures were categorized in as firm, medium, or loose with scores of 1, 0, and -1, respectively.

[5] Manure buildup was given the value of 1 for visual manure buildup and -1 for no visual manure buildup.