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The Effect of Live Yeast and Yeast Extracts on Growth Performance of Nursery Pigs Weaned from Sows Fed Diets with or without Yeast Additives

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Summary

A total of 340 weaned pigs (241 × 600, DNA; initially 11.2 lb BW) were used in a 45-d study to evaluate previous sow treatment (control vs. yeast additives) and nursery diets with or without added yeast-based pre- and probiotics (Phileo by Lesaffre, Milwaukee, WI) on growth performance. At placement in the nursery, pigs were housed by pen based on previous sow treatment and randomly assigned to 1 of 2 dietary treatments with 5 pigs per pen and 17 replications per treatment. Treatments were arranged in a 2 × 2 factorial with main effects of sow treatment (control vs. yeast-based pre- and probiotic diet; 0.10% ActiSaf Sc 47 HR+ and 0.025% SafMannan) and nursery treatment (control vs. yeast-based pre- and probiotic diet; 0.10% ActiSaf Sc 47 HR+, 0.05% SafMannan, and 0.05% NucleoSaf from d 0 to 7, then concentrations were lowered by 50% from d 7 to 24). All pigs were fed a common diet from d 24 to 45 post-weaning. Progeny from sows fed diets with yeast additives had increased ($P < 0.05$) ADG, ADFI, and BW from d 0 to 24 and d 0 to 45. However, pigs that were fed yeast additives in the nursery had an overall (d 0 to 45) tendency for reduced ADG ($P = 0.079$) and lighter ending BW ($P = 0.086$). In conclusion, offspring from sows fed a live yeast and yeast additives had increased ADG, ADFI, and BW. However, feeding live yeast and yeast additives only in the nursery tended to reduce ADG and ending BW.

Introduction

The post-weaning period is one of the most stressful periods in a pig's life. Separation from mother, transitioning from a liquid to solid diet, and a new environment with new pen-mates are all contributing factors that lead to the post-weaning growth lag and diarrhea (PWD). During this time frame, it is common for the colonization of enterotoxigenic *E. coli* (ETEC) in the gut, which is one of the main causes for PWD.[3]

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[1] Department of Diagnostic Medicine/Pathology, College of Veterinary Medicine, Kansas State University.

[2] Phileo by Lesaffre, Milwaukee, WI.

[3] Fairbrother, J. M., É. Nadeau, and C. L. Gyles. 2005. *Escherichia coli* in postweaning diarrhea in pigs: an update on bacterial types, pathogenesis, and prevention strategies. Anim. Heal. Res. Rev. 6:17–39. doi:10.1079/AHR2005105

Yeast-based pre- and probiotics have been of interest because of their potential to positively modulate gut microflora which may lead to improved immunity, nutrient digestion and absorption, and growth performance.[4] Thus, the objective of this study was to evaluate the live yeast *Saccharomyces cerevisiae* strain NCYC Sc 47 and yeast-based prebiotics derived from *Saccharomyces cerevisiae* on nursery pigs weaned from sows fed a diet with or without yeast additives on growth performance. The sow performance data are provided in Chance et al. (2021) Swine Day Research Report.[5] Our hypothesis was that the addition of live yeast (probiotic) and yeast extracts (prebiotics) would provide additive growth when fed both to sows and then to their offspring in the nursery.

Materials and Methods

General

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The facility is completely enclosed, environmentally controlled, and mechanically ventilated. Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide *ad libitum* access to feed and water. Pens (4 × 4 ft) had metal tri-bar floors and allowed approximately 2.7 ft^2/pig.

Animals and treatment structure

A total of 340 weaned pigs (241 × 600, DNA; initially 11.2 ± 0.07 lb BW), offspring of sows fed either a control diet or a diet containing yeast-based pre- and probiotics from d 110 of gestation through weaning, were used in a 45-d nursery study. Only 10 weaned pigs (7 from control litters and 3 from yeast additive litters) were not included in the nursery study to maintain an even number of replications per treatment and/or because of poor health. All other pigs were considered healthy with only ten pigs being removed from the nursery study. Pigs within the same sow treatment were kept together and allotted to pens, pens were then allotted to treatment with 5 pigs per pen and 17 replications per treatment in a completely randomized design.

Dietary treatments were arranged in a 2 × 2 factorial with main effects of sow treatment (control vs. yeast additives; 0.10% ActiSaf Sc 47 HR+ and 0.025% SafMannan; Phileo by Lesaffre, Milwaukee, WI) and nursery treatment (control vs. yeast additives; 0.10% ActiSaf Sc 47 HR+, 0.05% SafMannan, and 0.05% NucleoSaf from d 0 to 7 then concentrations were lowered by 50% from d 7 to 24; Phileo by Lesaffre, Milwaukee, WI). Thus, half of the pigs from each sow group was fed either a control diet or a diet with yeast additives. The live yeast *Saccharomyces cerevisiae* strain NCYC Sc 47 (ActiSaf Sc 47 HR+), served as the yeast-based probiotic. The yeast-based prebiotics included a yeast cell wall fraction with concentrated mannan-oligosaccharides and β-glucans from *Saccharomyces cerevisiae* (SafMannan) and a yeast extract containing ≥ 6% unbound nucleotides from *Saccharomyces cerevisiae* (NucleoSaf).

[4] Menegat, M. B., R. D. Goodband, J. M. DeRouchey, M. D. Tokach, J. C. Woodworth, and S. S. Dritz. 2019. Kansas State University Swine Nutrition Guide: Feed Additives in Swine Diets.

[5] Chance, J. A., J. T. Gebhardt, J. M. DeRouchey, M. D. Tokach, J. C. Woodworth, R. D. Goodband, and J. A. Loughmiller. 2021. The Effect of Live Yeast and Yeast Extracts Included in Lactation Diets on Sow and Litter Performance. *Kansas Agricultural Experiment Station Research Reports:* Vol. 7, Issue 11.

Diet preparation
Pigs were fed experimental phase 1 diets from placement until d 7 and then offered experimental phase 2 diets from d 7 to 24 (Table 1). A common phase 3 diet without live yeast or yeast extracts was fed to all pigs from d 24 to 45 (Table 1). Phase 1 diets were formulated to 1.40% SID Lys and phase 2 and 3 diets were formulated to 1.35% SID Lys. All other nutrients were formulated to meet or exceed NRC (2012)[6] requirement estimates. Phase 1 and 2 diets were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center (Manhattan, KS) and the common phase 3 diet was manufactured by a commercial feed mill (Hubbard Feeds; Beloit, KS). All three phases were fed in meal form. Pens of pigs were weighed, and feed disappearance recorded weekly during the course of this study to determine ADG, ADFI, and F/G.

Chemical analysis
Phase 1 and 2 diet samples were collected at manufacturing and phase 3 diets were collected from every fourth 50 lb bag using a feed probe to obtain a representative sample for each respective diet and phase. Complete diet samples were stored at -4°F until they were homogenized, subsampled, and submitted for analysis. Samples per dietary treatment were analyzed (Analabs; Fulton, IL) for active live yeast in phase 1 and 2 diets.

Statistical analysis
Growth performance data were analyzed using the nlme package of R (Version 4.0.0, R Foundation for Statistical Computing, Vienna, Austria) as a completely randomized design with pen as the experimental unit. The main effects of sow treatment and nursery treatment, as well as their interactions, were tested. Differences between treatments were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion
In phase 1 (d 0 to 7), there were no main effects ($P > 0.10$) observed for ADG, ADFI, or F/G for sow or nursery treatments (Table 2 and 3). There was a tendency ($P = 0.084$) for an interaction of sow and nursery treatment for improved F/G of progeny fed live yeast and yeast extracts from sows fed the yeast-based products, but the poorest F/G occurred when offspring were fed control diets after nursing sows were fed the yeast-based products. There were no further interactions observed during any periods or the overall study between sow treatment and nursery treatment for any growth performance criteria.

Pigs weaned from sows fed the yeast-based pre- and probiotics entered the nursery at a heavier BW ($P < 0.001$; 11.5 vs. 11.0 lb) compared to offspring from the control sows. There was statistical difference ($P < 0.001$) in d 7 BW with offspring from sows fed the yeast-based pre- and probiotics having a heavier BW at the end of phase 1.

In phase 2 (d 7 to 24) and for the overall experimental period (d 0 to 24), progeny from sows fed the yeast-based pre- and probiotics had increased ($P < 0.05$) ADG, ADFI, and heavier d 24 BW; however, there was no evidence for difference ($P > 0.10$) in F/G.

[6] National Research Council. 2012. Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. doi:10.17226/13298.

There was no evidence for statistical difference (*P* > 0.10) observed for nursery dietary treatment on any growth criteria.

During the common period (d 24 to 45), there were main effects (*P* < 0.05) of both sow and nursery treatments on ADG. Offspring from sows fed the yeast-based pre- and probiotics had increased ADG, heavier (*P* < 0.001) d 45 BW, and a tendency (*P* = 0.057) for increased ADFI compared to progeny from sows fed the control diet. Pigs fed the control diet in the nursery had increased (*P* = 0.011) ADG and a tendency (*P* = 0.060) for increased ADFI compared to those fed the diet containing live yeast and yeast extracts. There was no evidence for statistical difference (*P* > 0.10) in F/G for sow or nursery treatment.

For the overall period (d 0 to 45), progeny from sows fed the yeast-based products had evidence (*P* < 0.02) for increased BW, ADG, ADFI, and improved F/G compared to pigs from sows fed the control diet. There was a tendency for increased (*P* = 0.079) ADG and increased (*P* = 0.086) BW for pigs fed the control diet in the nursery compared to those fed the yeast-based pre- and probiotics. There was no statistical difference (*P* > 0.10) in ADFI or F/G for nursery treatment.

In conclusion, offspring from sows fed a live yeast and yeast additives had increased ADG, ADFI, and BW. However, feeding live yeast and yeast additives only in the nursery tended to reduce ADG and ending BW.

Table 1. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3
Ingredients, %			
Corn	44.36	57.40	64.73
Soybean meal (46.5% CP)	18.12	26.35	31.30
Whey powder	25.00	10.00	---
Fish meal	4.50	---	---
Enzymatically-treated soybean meal[2]	3.75	2.00	---
Soybean oil	1.50	---	---
Calcium carbonate	0.30	0.90	0.85
Monocalcium phosphate (21% P)	0.48	1.10	1.00
Salt	0.30	0.55	0.60
L-Lys-HCl	0.43	0.51	0.52
DL-Met	0.22	0.22	0.21
L-Thr	0.18	0.21	0.22
L-Trp	0.07	0.06	0.06
L-Val	0.13	0.14	0.13
Vitamin premix	0.25	0.25	---
Vitamin premix with phytase[3]	---	---	0.25
Trace mineral premix[4]	0.15	0.15	0.15
Phytase[5]	0.08	0.08	---
Yeast additives[6]	±	±	---
Total	100	100	100

continued

Table 1. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3
Calculated analysis			
SID amino acids, %			
Lys	1.40	1.35	1.35
Ile:Lys	56	55	55
Leu:Lys	109	112	114
Met:Lys	38	36	36
Met and Cys:Lys	57	57	57
Thr:Lys	63	63	63
Trp:Lys	20.6	20.2	20.3
Val:Lys	69	69	69
His:Lys	32	34	36
Total Lys, %	1.54	1.48	1.49
ME, kcal/lb	1,554	1,489	1,487
NE, kcal/lb	1,171	1,107	1,098
SID Lys:NE, g/Mcal	5.42	5.53	5.57
CP, %	20.9	20.5	21.2
Ca, %	0.69	0.77	0.69
P, %	0.68	0.66	0.61
STTD P, %	0.63	0.58	0.50

[1]Phase 1 diets were fed from d 0 to 7 (approximately 11.2 to 12.0 lb BW) and phase 2 diets were fed from d 7 to 24 (approximately 12.0 lb to 25.0 lb BW). Phase 1 and 2 diets were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center (Manhattan, KS). A common diet, without yeast additives, was fed during phase 3 from d 24 to 45 (approximately 25.0 to 60.0 lb BW) and was manufactured by Hubbard Feeds (Beloit, KS).
[2]HP 300, Hamlet Protein, Findlay, OH.
[3]Provided per lb of premix: 750,000 IU vitamin A; 300,000 IU vitamin D; 8,000 IU vitamin E; 600 mg vitamin K; 6 mg vitamin B_{12}; 9,000 mg niacin; 5,000 mg pantothenic acid; 1,500 mg riboflavin.
[4]Ronozyme HiPhos GT 2700 (DSM Nutritional Products, Parsippany, NJ) provided 566 FTU/lb and an expected STTD P release of 0.14%. Provided per lb of premix: 750,000 IU vitamin A; 300,000 IU vitamin D; 8,000 IU vitamin E; 600 mg vitamin K; 6 mg vitamin B_{12}; 9,000 mg niacin; 5,000 mg pantothenic acid; 1,500 mg riboflavin.
[5]Provided per lb of premix: 110 ppm Zn from Zn sulfate; 110 ppm Fe from iron sulfate; 10 ppm Mn from manganese oxide; 5 ppm Cu from copper sulfate; 0.3 ppm I from calcium iodate; 0.3 ppm Se from sodium selenite.
[6]Ronozyme HiPhos 2700 (DSM Nutritional Products, Parsippany, NJ) provided 918 FTU/lb and an estimated release of 0.16% STTD P in phases 1 and 2.
Yeast pre- and probiotics included 0.10% ActiSaf Sc 47 HR+, 0.05% SafMannan, and 0.05% NucleoSaf in phase 1 diets and then concentrations were lowered by 50% in phase 2 diets (Phileo by Lesaffre, Milwaukee, WI).

Table 2. Interactive effects of sow and nursery pig dietary treatment on growth performance of nursery pigs[1]

Sow treatment:[2]	Control		Yeast			*P* =		
Nursery treatment:[3]	Control	Yeast	Control	Yeast	SEM	Sow	Nursery	Sow × nursery
BW, lb								
d 0	11.1	11.0	11.5	11.5	0.07	< 0.001	0.507	0.507
d 7	11.9	11.8	12.4	12.3	0.15	0.001	0.516	0.825
d 24	25.4	25.1	27.2	26.9	0.47	< 0.001	0.569	0.968
d 45	58.5	57.8	62.2	60.3	0.78	< 0.001	0.086	0.476
Phase 1 (d 0 to 7)								
ADG, lb	0.12	0.10	0.12	0.12	0.017	0.719	0.604	0.654
ADFI, lb	0.25	0.25	0.27	0.26	0.014	0.351	0.585	0.637
F/G	2.37	2.47	3.68	1.29	0.710	0.928	0.112	0.084
Phase 2 (d 7 to 24)								
ADG, lb	0.79	0.78	0.86	0.85	0.021	0.002	0.653	0.920
ADFI, lb	1.10	1.09	1.18	1.15	0.032	0.026	0.530	0.864
F/G	1.39	1.40	1.37	1.35	0.022	0.150	0.711	0.681
Experimental period (d 0 to 24)								
ADG, lb	0.59	0.58	0.64	0.63	0.018	0.006	0.560	0.839
ADFI, lb	0.85	0.84	0.91	0.89	0.025	0.031	0.479	0.822
F/G	1.44	1.46	1.42	1.40	0.023	0.131	0.966	0.369
Phase 3 common diet (d 24 to 45)								
ADG, lb	1.58	1.54	1.66	1.59	0.021	0.003	0.011	0.369
ADFI, lb	2.39	2.34	2.47	2.39	0.036	0.057	0.060	0.747
F/G	1.52	1.51	1.49	1.51	0.012	0.127	0.493	0.372
Overall (d 0 to 45)								
ADG, lb	1.05	1.03	1.11	1.08	0.016	0.001	0.079	0.868
ADFI, lb	1.57	1.53	1.63	1.59	0.027	0.037	0.163	0.940
F/G	1.49	1.49	1.47	1.47	0.011	0.044	0.654	0.900

[1]A total of 340 pigs (initial BW of 11.2 ± 0.07 lb) were used in a 45-d nursery trial with 5 pigs per pen and 17 pens per treatment. Pigs were weaned at approximately 19 d of age and allotted to treatment in completely randomized design. Dietary treatments were arranged in a 2 × 2 factorial with main effects of sow treatment (control or yeast-based probiotics) and nursery pig treatment (control or yeast-based probiotics).
[2]Sow treatment consisted of providing a control diet or a yeast-based pre- and probiotic diet supplemented with ActiSaf Sc 47 HR+ at 0.10% and SafMannan at 0.03% (Phileo by Lesaffre, Milwaukee, WI) from d 110 of gestation until weaning.
[3]Nursery treatment consisted of providing a control diet or a yeast-based pre- and probiotic diet supplemented with 0.10% ActiSaf Sc 47 HR+, 0.05% SafMannan, and 0.05% NucleoSaf in phase 1 diets and then concentrations were lowered by 50% in phase 2 diets (Phileo by Lesaffre, Milwaukee, WI).

Table 3. Main effects of sow and nursery pig dietary treatment on growth performance of nursery pigs[1]

	Sow treatment[2]				Nursery treatment[3]			
Item	Control	Yeast	SEM	*P* =	Control	Yeast	SEM	*P* =
BW, lb								
d 0	11.0	11.5	0.05	< 0.001	11.3	11.2	0.05	0.507
d 7	11.8	12.4	0.11	0.001	12.2	12.1	0.11	0.516
d 24	25.2	27.1	0.33	< 0.001	26.3	26.0	0.33	0.569
d 45	58.1	61.3	0.55	< 0.001	60.4	59.0	0.55	0.086
Phase 1 (d 0 to 7)								
ADG, lb	0.11	0.12	0.012	0.719	0.12	0.11	0.012	0.604
ADFI, lb	0.25	0.26	0.010	0.351	0.26	0.25	0.010	0.585
F/G	2.42	2.48	0.502	0.928	3.02	1.88	0.502	0.112
Phase 2 (d 7 to 24)								
ADG, lb	0.79	0.86	0.015	0.002	0.83	0.82	0.015	0.653
ADFI, lb	1.09	1.17	0.023	0.026	1.14	1.12	0.023	0.530
F/G	1.39	1.36	0.016	0.150	1.38	1.37	0.016	0.711
Experimental period (d 0 to 24)								
ADG, lb	0.59	0.64	0.013	0.006	0.62	0.61	0.013	0.560
ADFI, lb	0.84	0.90	0.018	0.031	0.88	0.86	0.018	0.479
F/G	1.45	1.41	0.016	0.131	1.43	1.43	0.016	0.966
Phase 3 common diet (d 24 to 45)								
ADG, lb	1.56	1.63	0.015	0.003	1.62	1.57	0.015	0.011
ADFI, lb	2.36	2.43	0.025	0.057	2.43	2.36	0.025	0.060
F/G	1.52	1.50	0.008	0.127	1.50	1.51	0.008	0.493
Overall (d 0 to 45)								
ADG, lb	1.04	1.09	0.012	0.001	1.08	1.05	0.012	0.079
ADFI, lb	1.55	1.61	0.019	0.037	1.60	1.56	0.019	0.163
F/G	1.49	1.47	0.008	0.044	1.48	1.48	0.008	0.654

[1]A total of 340 pigs (initial BW of 11.2 ± 0.07 lb) were used in a 45-d nursery trial with 5 pigs per pen and 17 pens per treatment. Pigs were weaned at approximately 19 d of age and allotted to treatment in completely randomized design. Dietary treatments were arranged in a 2 × 2 factorial with main effects of sow treatment (control or yeast-based probiotics) and nursery pig treatment (control or yeast-based probiotics).

[2]Sow treatment consisted of providing a control diet or a yeast-based pre- and probiotic diet supplemented with ActiSaf Sc 47 HR+ at 0.10% and SafMannan at 0.03% (Phileo by Lesaffre, Milwaukee, WI) from d 110 of gestation until weaning.

[3]Nursery treatment consisted of providing a control diet or a yeast-based pre- and probiotic diet supplemented with 0.10% ActiSaf Sc 47 HR+, 0.05% SafMannan, and 0.05% NucleoSaf in phase 1 diets and then concentrations were lowered by 50% in phase 2 diets (Phileo by Lesaffre, Milwaukee, WI).