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

Jenna A. Chance  
*Kansas State University*, jchance10@ksu.edu

Jordan T. Gebhardt  
*Kansas State University*, jgebhardt@k-state.edu

Joel M. DeRouchey  
*Kansas State University*, jderouch@ksu.edu

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Abstract
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.

Keywords
nursery pigs, probiotic, yeast extract, yeast

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Authors
Jenna A. Chance, Jordan T. Gebhardt, Joel M. DeRouchey, Mike D. Tokach, Jason C. Woodworth, Robert D. Goodband, and Joseph A. Loughmiller

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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. 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. 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 x 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 x 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 x 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).

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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 \(P < 0.001\; (11.5 \text{ vs. } 11.0 \text{ lb})\) 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.

*Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.*
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 meal2     | 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 phytase3            | ---     | ---     | 0.25    |
| Trace mineral premix4                   | 0.15    | 0.15    | 0.15    |
| Phytase5                                 | 0.08    | 0.08    | ---     |
| Yeast additives6                        | ±       | ±       | ---     |
| Total                                   | 100     | 100     | 100     |

continued
Table 1. Diet composition (as-fed basis)¹

| Item                               | Phase 1 | Phase 2 | Phase 3 |
|------------------------------------|---------|---------|---------|
| 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    |

¹Phase 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).

²HP 300, Hamlet Protein, Findlay, OH.

³Provided 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 B₁₂; 9,000 mg niacin; 5,000 mg pantothenic acid; 1,500 mg riboflavin.

⁴Ronozyme 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 B₁₂; 9,000 mg niacin; 5,000 mg pantothenic acid; 1,500 mg riboflavin.

⁵Provided 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.

⁶Ronozyme 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

| Nursery treatment: | 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)| 0.79    | 0.78  | 0.86    | 0.85  | 0.021| 0.002 | 0.653  | 0.920         |
| ADG, lb           | 1.10    | 1.09  | 1.18    | 1.15  | 0.032| 0.026 | 0.530  | 0.864         |
| ADFI, lb          | 1.39    | 1.40  | 1.37    | 1.35  | 0.022| 0.150 | 0.711  | 0.681         |
| Experimental period (d 0 to 24)| 0.59    | 0.58  | 0.64    | 0.63  | 0.018| 0.006 | 0.560  | 0.839         |
| ADG, lb           | 0.85    | 0.84  | 0.91    | 0.89  | 0.025| 0.031 | 0.479  | 0.822         |
| ADFI, lb          | 1.44    | 1.46  | 1.42    | 1.40  | 0.023| 0.131 | 0.966  | 0.369         |
| Phase 3 common diet (d 24 to 45)| 1.58    | 1.54  | 1.66    | 1.59  | 0.021| 0.003 | 0.011  | 0.369         |
| ADG, lb           | 2.39    | 2.34  | 2.47    | 2.39  | 0.036| 0.057 | 0.060  | 0.747         |
| ADFI, lb          | 1.52    | 1.51  | 1.49    | 1.51  | 0.012| 0.127 | 0.493  | 0.372         |
| Overall (d 0 to 45)| 1.05    | 1.03  | 1.11    | 1.08  | 0.016| 0.001 | 0.079  | 0.868         |
| ADG, lb           | 1.57    | 1.53  | 1.63    | 1.59  | 0.027| 0.037 | 0.163  | 0.940         |
| ADFI, lb          | 1.49    | 1.49  | 1.47    | 1.47  | 0.011| 0.044 | 0.654  | 0.900         |

1A 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).

2Sow 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.

3Nursery 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

| Item                  | Sow treatment¹ | Nursery treatment¹ |
|-----------------------|----------------|-------------------|
|                       | Control        | Yeast             | SEM  | Control | Yeast | SEM  | P = |
| BW, lb                |                |                   |      |         |       |      |     |
| d 0                   | 11.0           | 11.5              | 0.05 | 0.012   | 0.719 | 0.11 | < 0.001 |
| d 7                   | 11.8           | 12.4              | 0.11 | 0.010   | 0.351 | 0.26 | 0.11 |
| d 24                  | 25.2           | 27.1              | 0.33 | 0.003   | 2.43  | 2.48 | 0.502 |
| d 45                  | 58.1           | 61.3              | 0.55 | 0.001   | 6.2   | 6.4  | 0.55 |
| Phase 1 (d 0 to 7)    |                |                   |      |         |       |      |     |
| ADG, lb               | 0.11           | 0.12              | 0.012| 0.001   | 2.43  | 2.48 | 0.502 |
| ADFI, lb              | 0.25           | 0.26              | 0.010| 0.013   | 0.016 | 0.150| 0.137 |
| F/G                   | 2.42           | 2.48              | 0.502| 0.006   | 0.006 | 0.131| 0.137 |
| Phase 2 (d 7 to 24)   |                |                   |      |         |       |      |     |
| ADG, lb               | 0.79           | 0.86              | 0.015| 0.013   | 2.43  | 2.48 | 0.502 |
| ADFI, lb              | 1.09           | 1.17              | 0.023| 0.031   | 0.016 | 0.143| 0.137 |
| F/G                   | 1.39           | 1.36              | 0.016| 0.061   | 0.061 | 0.150| 0.137 |
| Experimental period (d 0 to 24) |            |                   |      |         |       |      |     |
| ADG, lb               | 0.59           | 0.64              | 0.018| 0.018   | 1.39  | 1.41 | 0.016 |
| ADFI, lb              | 0.84           | 0.90              | 0.018| 0.031   | 0.016 | 0.143| 0.137 |
| F/G                   | 1.45           | 1.41              | 0.016| 0.067   | 0.067 | 0.150| 0.137 |
| Phase 3 common diet (d 24 to 45) |          |                   |      |         |       |      |     |
| ADG, lb               | 1.56           | 1.63              | 0.015| 0.015   | 2.43  | 2.43 | 0.025 |
| ADFI, lb              | 2.36           | 2.43              | 0.025| 0.057   | 1.39  | 1.41 | 0.016 |
| F/G                   | 1.52           | 1.50              | 0.008| 0.127   | 0.127 | 1.50 | 1.51 |
| Overall (d 0 to 45)   |                |                   |      |         |       |      |     |
| ADG, lb               | 1.04           | 1.09              | 0.012| 0.012   | 1.39  | 1.41 | 0.016 |
| ADFI, lb              | 1.55           | 1.61              | 0.019| 0.037   | 1.39  | 1.41 | 0.016 |
| F/G                   | 1.49           | 1.47              | 0.008| 0.044   | 1.48  | 1.48 | 0.008 |

¹A 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).

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