

2019

Effects of Oceanfeed Swine Feed Additive on Performance of Sows and Their Offspring

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Recommended Citation

Del Tuffo, L.; Laskoski, F.; Vier, C. M.; Tokach, M. D.; Dritz, S. S.; Woodworth, J. C.; DeRouchey, J. M.; Goodband, R. D.; Constance, L. A.; Niederwerder, M.; and Arkfeldt, E. (2019) "Effects of Oceanfeed Swine Feed Additive on Performance of Sows and Their Offspring," *Kansas Agricultural Experiment Station Research Reports*: Vol. 5: Iss. 8. <https://doi.org/10.4148/2378-5977.7834>

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Funding Source

Appreciation is expressed to Ocean Harvest Technology Company Ltd, Galway, Ireland, for providing the seaweed blend probiotic and partial financial support.

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Effects of Oceanfeed Swine Feed Additive on Performance of Sows and Their Offspring¹

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Summary

The objective of this study was to evaluate the effects of the Oceanfeed Swine™ feed additive on sows and their offspring performance. Oceanfeed Swine is a product created by drying and blending a selected mix of brown, red, and green seaweeds (Ocean Harvest Technology, Galway, Ireland). A total of 28 sows (DNA 241, DNA Genetics, Columbus, NE) and litters were used from d 30 of gestation until weaning (d 20 of lactation). Treatments consisted of providing a control diet (n = 14 sows) or the Oceanfeed Swine diet (n = 14 sows) added at 0.5% of complete diet in gestation and 0.66% in lactation diets. Then offspring of these sows were used for the nursery and grow-finish portions of the study. In the nursery, a total of 360 weanling pigs (DNA 241 × 600), were used in a 56-d trial. There were 5 pigs per pen and 18 replications per treatment. Treatments were arranged in a split-plot design with sow treatment (control vs. Oceanfeed Swine diet) as a whole-plot and nursery treatment (control vs. Oceanfeed Swine diet) as the sub-plot. In the nursery phase, the Oceanfeed Swine was added at 0.75% of the diet. During the nursery phase, fecal scoring was used to categorize fecal consistency and fecal samples were collected for microbial analysis. At the end of the nursery portion, pigs from two nursery pens within weight block and treatment were combined and moved to the finishing barn with approximately 10 pigs per pen and 9 replications per treatment. Pigs were weighed weekly (nursery) or every two weeks (finisher) to determine growth performance. At the conclusion of the finishing phase, all pigs were marketed for carcass data collection.

The addition of the Oceanfeed Swine in sow diets during gestation and lactation did not influence ($P > 0.10$) sow body weight (BW) at the end of gestation or at weaning. Also, there were no differences in colostrum yield, colostrum and milk composition, or litter performance between the two treatments during the lactation period. In the nursery, there was no evidence for the effect of sow by nursery treatment, interactions

¹ Appreciation is expressed to Ocean Harvest Technology Company Ltd, Galway, Ireland, for providing the seaweed blend probiotic and partial financial support.

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($P > 0.10$) observed. For the overall nursery period (weaning to day 56), no sow or nursery effects were observed for growth performance. For fecal scores, there was a sow $\times$ nursery treatment interaction ($P < 0.062$) observed. In general, pigs weaned from control sows then fed the control diet, or pigs weaned from Oceanfeed Swine sows and fed Oceanfeed Swine had firmer fecal scores than the other two combinations. There was also a sow treatment by day interaction ($P < 0.007$) observed with pigs weaned from control sows initially (day 7) having firmer feces than those weaned from sows fed Oceanfeed Swine in the nursery. However, by day 21, there appeared to be no differences in fecal consistency among pigs weaned from either sow treatment group. For microbial analysis, there was a marginally significant increase in the proportion of pigs with the families Peptostreptococcaceae and Veillonellaceae detected in the pigs from sows fed Oceanfeed Swine diets and fed Oceanfeed Swine compared with the control group ($P = 0.085$). Moreover, pigs from sows that were fed Oceanfeed Swine diet and then fed Oceanfeed Swine had an increased ($P = 0.048$) mean number of species detected within the family Ruminococcaceae and had a marginally significant increased ($P = 0.076$) mean number of species detected within the family Lachnospiraceae, two families that are generally considered beneficial. Finally, pigs from sows that were fed Oceanfeed Swine diets, then fed Oceanfeed Swine had marginally significant lower ($P = 0.069$) mean number of species detected within the family Fusobacteriaceae, a family that is generally considered pathogenic.

In the finishing period, a sow by finishing treatment interaction ($P = 0.061$) was observed for F/G from d 0 to 55 after weaning. Pigs weaned from sows fed control diets and switched to Oceanfeed Swine in the nursery or pigs weaned from sows fed Oceanfeed Swine then fed control diets in the finishing phase had improved F/G compared with the two other treatment combinations. No evidence for any main effect differences ($P > 0.10$) was observed on overall growth performance. However, sow by finishing treatment interaction ($P = 0.059$) was observed for backfat depth. This interaction was similar to the day 0 to 55 F/G response. Pigs weaned from sows fed control diets and then fed control diets in the nursery/finishing period had greater backfat depth and decreased percentage lean compared with other treatment combinations (sow treatment $\times$ nursery/finishing treatment interaction ($P < 0.073$)).

In summary, the addition of Oceanfeed Swine in gestation, lactation, and the nursery/finishing phases had no consistent effect on sow or litter performance. However, a shift in the microbiota was observed in the pigs from sows fed Oceanfeed Swine diet, then fed Oceanfeed Swine with higher number of species detected within Ruminococcaceae and Lachnospiraceae families that are generally considered beneficial and lower number of species within the family Fusobacteriaceae that is normally considered pathogenic.

Introduction

In the last decade, food security and antibiotic use in livestock production have gained much attention. The priority of producing more animal protein to feed a thriving human population has been challenged by the concern of overusing antibiotics in their diets. For this reason, many alternatives have been evaluated to replace the use of antibiotics for growth promotion. Among these, dried seaweed blends have recently

gained attention.⁴ Seaweeds are rich in non-digestive polysaccharides, such as laminarin, fucoidan, and alginic acid.^{5,6} It's been stated that these components have several positive effects, such as improving the growth performance of suckling and finishing pigs,^{7,8,9} by increasing colostrum IgG concentration in sows.¹⁰ Also, changes in the intestinal microbiota have been described with a reduction of colonic *Escherichia coli* in suckled and nursery pigs.¹⁰ However, seaweeds have a highly variable composition depending on the species, time of harvest, habitat and growing conditions such as water temperature, light intensity, and nutrient concentration in water.

Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) is created by drying and blending a selected mix of brown, red, and green seaweeds harvested from the cold waters of Europe and warm water in Southeast Asia. It is hypothesized that polysaccharides such as laminarin and fucoidan present in these seaweeds have positive effects on colostrum immunoglobulins output, the gut environment, and the growth performance of pigs. Therefore, the objective of this study was to investigate the effect of the dietary addition of Oceanfeed Swine on sow performance during gestation and lactation, growth performance of their offspring during nursery and grow finish, and fecal microbiome.

Procedures

The Kansas State University Institutional Care and Use Committee approved the protocol used in this experiment. The experiment was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. This study was divided into a sow portion, from d 30 of gestation to weaning; a nursery portion, from weaning to d 56; and a grow-finish portion, from d 56 until market. Thus, four treatments were provided with sows fed diets with or without Oceanfeed Swine and then, their offspring fed diets with or without Oceanfeed Swine in the nursery and grow-finish stages (Table 1).

⁴ Makkar, H. P. S., G. Tran, V. Heuze, S. Gifer-Reverdin, M. Lessire, F. Lebas and P. Ankers. 2016. Seaweeds for livestock diets: A review. *J. Anim. Sci. Technol.* 212:1-17. doi:10.1016/j.anifeedsci.2015.09.018.

⁵ Rajauria, G., J. Draper, M. McDonnell, and J. V. O'Doherty. 2016. Effect of dietary seaweed extracts, galactooligosaccharide and vitamin E supplementation on meat quality parameters in finisher pigs. *Innov. Food Sci. Emerg. Technol.* 37:269-275. doi:10.1016/j.ifset.2016.09.007.

⁶ Zvyagintseva, T.N., N. M. Shevchenko, A.O. Chizhov, T.N. Krupnova, E.V. Sundukova, and V.V. Isakov. 2003. Water-soluble polysaccharides of some far-eastern brown seaweeds. Distribution, structure, and their dependence on the developmental conditions. *J. Exp. Mar. Biol. Ecol.* 294:1-13.

⁷ Leonard, S. G., T. Sweeney, B. Bhar, B. P. Lynch, and J. V. O'Doherty. 2011. Effects of dietary seaweed extract supplementation in sows and post-weaned pigs on performance, intestinal morphology, intestinal microflora and immune status. *Br. J. Nutr.* 106:688-699. doi:10.1017/S0007114511000997.

⁸ Ruiz, A.R., P. Gadick, S. M. Andrades, and R. Cubillos. 2018. Supplementing nursery pig feed with seaweed extracts increases final body weight of pigs. *Austral J Vet Sci* 50:83-87. doi: 10.4067/S0719-81322018000200083.

⁹ Heim, G., T. Sweeney, C. J. O'Shea, D. N. Doyle, and J. V. O'Doherty. 2014. Effect of maternal supplementation with seaweed extracts on growth performance and aspects of gastrointestinal health of newly weaned piglets after challenge with enterotoxigenic *Escherichia coli* K88. *Br. J. Nutr.* 112:1955-1965. doi:10.1017/S0007114514003171.

¹⁰ Leonard, S. G., T. Sweeney, B. Bahar, B. P. Lynch, and J. V. O'Doherty. 2010. Effect of maternal fish oil and seaweed extract supplementation on colostrum and milk composition, humoral immune response, and performance of suckled piglets. *J. Anim. Sci.* 88:2988-2997. Doi:10.2527/jas.2009-2764.

Table 1. Dietary treatments

Treatment	Gestation and lactation	Nursery	Grow/finish
A	Control	Control	Control
B	Control	Oceanfeed Swine	Oceanfeed Swine
C	Oceanfeed Swine	Control	Control
D	Oceanfeed Swine	Oceanfeed Swine	Oceanfeed Swine

Sow Portion

For the sow portion, a total of 28 sows (DNA 241, DNA Genetics, Columbus, NE) with confirmed pregnancy were individually weighed and assigned to dietary treatments in a randomized complete block design based on parity and BW on day 30 of gestation. During gestation and lactation sows were individually housed in environmentally-controlled and mechanically-ventilated barns. Dietary treatments consisted of a control diet and a diet containing Oceanfeed Swine.

Gestation diets were fed from d 30 to 112 of gestation (Table 2). On a daily basis, treatments were top dressed in a common gestation diet according to daily feed allowance. Sows were fed 4.5, 5.5, or 6.5 lb/d of gestation diet according to body condition and BW. In the control diet the top dress contained ground corn. In the Oceanfeed Swine diet, the top dress contained ground corn and Oceanfeed Swine to achieve an equivalent of 0.5% of the sow's daily feed allowance.

Lactation diets (control or Oceanfeed Swine, 0.66% of the diet) were fed from day 112 of gestation to weaning at approximately day 20 of lactation (Table 2). Sows were fed 6 lb/d from day 112 until farrowing and *ad libitum* feed intake from farrowing to weaning. Daily feed allowance was delivered and recorded by an electronic feeding system (Gestal Solo Feeders Jyga Technologies, Quebec City, Quebec, Canada).

During lactation, piglets were cross-fostered within sow treatment group to equalize litter size on day 2. Nursing piglets had access to water, but no creep feed was used.

Sow performance was determined by recording feed intake on a daily basis and BW at day 30 and 112 of gestation and on day 1 and 20 after farrowing. Farrowing and litter performance were assessed by recording number of piglets total born, born alive, and stillborn, and recording individual piglet BW at birth. Litter size and pig weights were recorded on day 2 and 19. Pre-weaning survival was measured as the difference in pigs equalized on day 2 and those weaned on day 19 divided by the number of pigs on day 2.

In order to estimate colostrum yield, piglets were weighed at birth and 24 h later, according to the method described by Theil.¹¹ Additionally, colostrum and milk samples were collected during parturition and on day 10 of lactation. To facilitate milk collection on day 10, piglets were removed from the sow and milk ejection was induced by perivulvar administration of 2 mL oxytocin. Milk and colostrum samples were analyzed for fat and total solids content using the CEM SMART Trac II Rapid Fat and Mois-

¹¹ Theil, P. K. 2017. Estimation of colostrum and milk production in sows. Thai J. Vet. Med. Suppl. 47:S7-S9.

ture/Solids Analyzer (CEM Corporation, Mathews, NC). Protein content was determined by combustion using a Leco TruMac N with TruMac operating software. Also, colostrum IgG concentration was determined by using a specific pig-Elisa kit (Bethyl Laboratories Inc., Montgomery, TX).

Nursery Portion

A total of 360 weaned pigs (DNA 241 × 600), progeny of the sows in the study, were used in a 56-d study starting at weaning. At weaning, pigs were weighed and assigned to nursery pens in a split-plot design with lactation treatment as the whole-plot and nursery treatment as the sub-plot. There were 5 pigs per pen and 18 replications per treatment. The 4 treatments in the nursery phase consisted of: pigs from sows fed control diet in gestation and lactation, then fed either a control diet or a diet containing a 0.75% Oceanfeed Swine diet. The remaining two treatments were pigs from the Oceanfeed Swine fed sows, weaned, and fed either a control or Oceanfeed Swine diet.

Nursery performance was assessed by recording BW and feed disappearance on d 7, 14, 21, and 56 to determine average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G). Also, fecal scores were determined on d 7, 14, and 21. Fecal scoring was categorized as a numerical scale from 1 to 5 as follows: 1, hard feces like pellet; 2, firm formed stool; 3, soft moist stool that retains shape; 4, soft unformed stool; and 5, watery liquid stool. Fecal scoring was performed by 3 trained individuals and the combined score was considered as the pen score.

Additionally, at weaning, day 14, and 56, fecal samples were collected directly from the rectum using mini cotton tip swabs from 1 pig per pen and 12 pens per treatment for microbial analysis. Fecal samples from day 56 were analyzed in pigs from sows fed the control diet in gestation and lactation, then fed the control diet (treatment A), and pigs from sows fed the Oceanfeed Swine diet, then fed Oceanfeed Swine diet (Treatment D) using the Lawrence Livermore Microbial Detection Array (LLMDA) as previously described.^{12,13}

Diets were based on corn and soybean meal and were fed in four dietary phases: phase 1, fed from d 0 to 7 in pellet form; phase 2, fed from d 7 to 21 in meal form; phase 3, fed from d 21 to 42 in meal form; and phase 4, fed from d 42 to 56 in meal form (Table 3). Phase 1 diets were pelleted under the following parameters: 123°F average conditioning temperature, 161°F average hot pellet temperature, 3/16 × 1 1/4 inch die size (L/D = 6.0), 1,560 lb/h production rate, and 73°F ambient temperature. Diets were formulated to meet or exceed NRC¹⁴ nutrient requirement estimates.

¹² Niederwerder, M. C., C. J. Jaing, J. B. Thissen, A. G. Cino-Ozuna, K. S. McLoughlin and R. R. R. Rowland. 2016. Microbiome associations in pigs with the best and worst clinical outcomes following co-infection with porcine reproductive and respiratory syndrome virus (PRRSV) and porcine circovirus type 2 (PCV2). *Vet. Microbiol.* 188:1-11. doi: 10.1016/j.vetmic.2016.03.008.

¹³ Ober R. A., J. B. Thissen, C. J. Jaing, A. G. Cino-Ozuna, R. R. R. Rowland and M. C. Niederwerder. 2017. Increased microbiome diversity at the time of infection is associated with improved growth rates of pigs after co-infection with porcine reproductive and respiratory syndrome virus (PRRSV) and porcine circovirus type 2 (PCV2). *Vet. Microbiol.* 208:203–211. doi: 10.1016/j.vetmic.2017.06.023.

¹⁴ National Research Council. 2012. *Nutrient Requirements of Swine: Eleventh Revised Edition*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13298>.

Finishing Portion

At the end of the nursery period, pigs from two nursery pens within weight block and treatment were combined and placed in each grow-finish pen with approximately 10 pigs per pen and 9 replications per treatment. The facility was totally enclosed and environmentally regulated, containing 36 pens. Each pen (10 × 8 ft) was equipped with a dry, single-sided feeder (Farmweld, Teutopolis, IL) with two feeder spaces and a 1-cup waterer. Pens were located over a completely slatted concrete floor with a 4-ft deep pit underneath for manure storage. A robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record daily feed additions to each individual pen. Pens were equipped with adjustable gates to allow space allowances per pig to be maintained if a pig died or was removed during the experiment.

Growth performance was assessed by recording BW and feed disappearance every 2 weeks and at the conclusion of the study (day 100). Then, pigs were individually tattooed with a unique ID number, and an RFID transponder was inserted into the left ear to allow carcass measurements to be recorded on a pig basis. On d 100, final pen weights and individual pig weights were taken, and pigs were transported approximately 2.5 h to a commercial packing plant (Triumph, St. Joseph, MO) for processing and determination of carcass characteristics.

Diets were based on corn and soybean meal and were fed in meal form in three dietary phases: phase 5, fed from d 0 to 27; phase 6, fed from d 27 to 55; and phase 7, fed from d 55 to 100 (Table 4). Diets were formulated to meet or exceed the NRC¹⁴ requirement estimates, and the Oceanfeed Swine was included at 0.75% of the diet in phase 5 and 0.50% in phases 6 and 7.

All experimental diets were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center in Manhattan, KS. Diet samples were collected at manufacturing for chemical analysis.

Statistical Analysis

For the sow portion of the study, data were analyzed using a linear mixed model. Treatment was included as fixed effect and block as random effect. Sow or litter were the experimental units. Born alive, stillborn, and pre-wean mortality were analyzed assuming a binomial distribution. Fecal score was analyzed assuming a multinomial distribution. Fecal score was analyzed as repeated measures.

In the nursery and finishing portion of the study, data were analyzed using a linear mixed model. Treatment was included as fixed effect and pen as the experimental unit. Preplanned contrast statements were built to evaluate the main effects and interactions of sow treatment by nursery/finishing treatment. Hot carcass weight was used as a covariate for analyses of backfat, loin depth, and lean percentage. Statistical models were fitted using the GLIMMIX procedure of SAS version 9.4 (SAS Institute Inc., Cary, NC). Results were considered significant at $P \leq 0.05$ and marginally significant at $P > 0.05$ and $P \leq 0.10$.

For the microbiota analysis, diversity was calculated as the mean number of families and species detected in each group. The number of families and species in each sample were

fit in a generalized linear model using a binomial distribution. The `glm` function from the `lme4` package in R (R Core Team, 2015, Vienna, Austria) was used for the analysis. The proportion of individual families present within each treatment was fit in a generalized linear mixed model using a binomial distribution. The `glmer` function from the `lme4` package in R was used in order to account for the nature of the binary response variable and the randomized complete block design structure. The mean number of species within family were recorded as counts and a generalized linear model following a Poisson distribution was used. Since the blocking factor was not being estimated, the block term was dropped from the model. The `glm` function from the `lme4` package in R was used for the analysis.

Results and Discussion

Sow Portion

Addition of Oceanfeed Swine to sow diets during gestation and lactation did not influence ($P > 0.10$) sow BW at the end of gestation or at weaning (Table 5). There was no evidence for differences ($P > 0.10$) in the number of piglets total born, born alive, stillborn, or piglet birth weight between sows fed control or Oceanfeed Swine diets. Growth performance and pre-weaning mortality of the litters were not influenced by treatments in the lactation period. Colostrum yield was not influenced by dietary treatment. Total solids, fat content, protein concentration, and IgG did not differ between treatments (Table 6).

Nursery Portion

There was no evidence for interaction ($P > 0.10$) between sow and nursery treatments for ADG, ADFI, or F/G (Tables 7 and 8). Pigs weaned from the sows fed control diet had greater ($P = 0.001$) weight at the beginning of the nursery period than those fed the Oceanfeed Swine. This significant difference is the consequence of allotting pigs in small, medium, and heavy weight blocks that reduced the weight variability within blocks. In phase 1 (d 0 to 7), there was a marginally significant ($P = 0.06$) increase in ADG of pigs weaned from sows fed the control diet compared with those weaned from sows fed the Oceanfeed Swine diet. Pigs fed Oceanfeed Swine had a marginally significant ($P = 0.055$) improvement in F/G. From day 7 to 21, pigs fed the Oceanfeed Swine diet had poorer ($P = 0.009$) F/G driven by a marginally significant ($P = 0.055$) increase in ADFI. Overall (d 0 to 56 post-weaning), there was no evidence ($P > 0.10$) for effect of sow or nursery treatment on pig growth performance.

There was a marginally significant ($P = 0.062$) sow $\times$ nursery treatment interaction for pig fecal scores. Pigs weaned from sows fed the control diet that were fed the Oceanfeed Swine diet, or pigs weaned from Oceanfeed Swine sows then fed the control diet in the nursery, had increased frequency distribution of unformed softer feces compared to pigs weaned from sows fed the control diet that were fed control diet in the nursery, or pigs weaned from sows fed Oceanfeed Swine and remained on Oceanfeed Swine in the nursery (Figure 1). There was also a sow treatment $\times$ day interaction ($P < 0.007$) observed with pigs weaned from control sows initially (day 7) having firmer feces than those weaned from sows fed the Oceanfeed Swine. However, by day 21, there appeared to be no differences in fecal consistency among pigs weaned from either sow treatment group (Figure 2).

Microbiome diversity of the fecal samples was measured by calculating the number of families and species detected in each sample. Many families and species were detected in both groups (Figure 3). No significant differences were observed in family and species diversity between the two groups ($P > 0.05$). The mean number of families detected in the pigs from sows fed control diets during gestation and lactation, then fed control was 35.3 ± 1.72 , while the pigs from sows fed Oceanfeed Swine diets, then fed Oceanfeed Swine had 36.8 ± 1.75 . The mean number of species detected in the pigs from sows fed control, then fed control was 61.4 ± 2.26 , while the pigs from sows fed Oceanfeed Swine, then fed Oceanfeed Swine had 65.4 ± 2.33 .

Microbiome composition was also analyzed using the LLMDA method by the proportion of samples with each family detected (Figure 3A) and the mean number of species within that family (Figure 3B). At the family level, a trend with higher proportion of Peptostreptococcaceae was detected in the pigs from sows fed Oceanfeed Swine diet then fed Oceanfeed Swine compared with the control group (41 and 8%, respectively; $P = 0.085$). A similar trend was observed for the Veillonellaceae family, detected at an increased prevalence rate in the pigs from sows fed Oceanfeed Swine diet then fed Oceanfeed Swine compared with the control group (92 and 58%, respectively; $P = 0.085$). Unfortunately, there is a lack of information based on the role of these organisms on the vertebrate gut microbiome.

At a species level, a higher mean number of species within the family Ruminococcaceae was detected in the pigs from sows fed Oceanfeed Swine diet, then fed Oceanfeed Swine compared with the control (1.42 and 0.58, respectively; $P = 0.0482$). Additionally, a trend for higher number of species within the family Lachnospiraceae was detected in the pigs fed Oceanfeed Swine diet, then fed Oceanfeed Swine compared with the control (4 and 2.7, respectively; $P = 0.076$). The increase in the diversity of species within these two families can be considered a desirable trait since they are well known for degradation of complex carbohydrates and short chain fatty acid production.^{15,16} Moreover, a trend for lower mean number of species within the family Fusobacteriaceae was detected in pigs from sows fed Oceanfeed Swine diets, then fed Oceanfeed compared with the control (8 and 56%, respectively; $P = 0.089$). The family Fusobacteriaceae has been associated with a wide spectrum of diseases in humans and animals.¹⁷ Moreover, it has been reported that the relative abundance of species from the family Fusobacteriaceae significantly increases in piglets with diarrhea.¹⁸ Overall, the analysis did not detect family or species diversity differences; however, a shift in microbiome composition was detected in pigs from sows fed Oceanfeed Swine diets, then fed Oceanfeed Swine compared with the control, with an increase in the mean number of

¹⁵ Biddle A., L. Stewart, J. Blanchard, and S. Leschine. 2013. Untangling the genetic basis of fibrolytic specialization by lachnospiraceae and ruminococcaceae in diverse gut communities. *Diversity*, 5:627-640. doi:10.3390/d5030627.

¹⁶ Umu O. C. O., J. A. Frank, J. U. Fangel, M. Oostindjer, C. S. Silva, E. J. Bolhuis, G. Bosch, W. G. T. Willats, P. B. Pope, and D. B. Diep. 2015. Resistant starch diet induces change in the swine microbiome and a predominance of beneficial bacterial population. *Microbiome*. doi:10.1186/s40168-015-0078-5.

¹⁷ E. Rosenberg, E.F. DeLong, S. Lory, E. Stackebrandt, F. Thompson (Eds.). 2014. *The Prokaryotes*, Springer-Verlag, Berlin Heidelberg 9:109-132. doi:10.1007/978-3-642-30120-9_213.

¹⁸ Yang Q., X. Huang, S. Zhao, W. Sun, Z. Yan, P. Wand, S. Li, W. Huang, S. Zhang, L. Liu, and S. Gun. 2017. Structure and function of the fecal microbiota in diarrheic neonatal piglets. *Front. Microbiol.* 8:502. doi:10.3389/fmicb.2017.00502.

species within families that are generally considered beneficial and a reduction in the mean number of species within a family that are generally considered pathogenic.

Finishing Portion

In the finishing period, a sow $\times$ finishing treatment interaction ($P = 0.061$) was observed for F/G from d 0 to 55 after weaning (Table 9). Pigs weaned from sows fed control diets and then fed Oceanfeed Swine diets in the nursery/finishing period had improved F/G compared with pigs weaned from sows fed control diets and then fed control diets in the nursery/finishing period. Also, pigs weaned from sows fed Oceanfeed Swine diets and then fed control diets in the nursery/finishing period had improved F/G compared with pigs weaned from sows fed Oceanfeed Swine diets and then fed Oceanfeed Swine diets in the nursery/finishing period. No evidence for any interactive or main effect differences ($P > 0.10$) was observed for overall finishing pig growth performance (Table 10). A sow $\times$ nursery treatment interaction was observed for backfat depth and percentage lean. Pigs weaned from sows fed control diets and then fed control diets in the nursery/finishing period had greater backfat depth ($P < 0.059$) and decreased ($P < 0.073$) percentage lean than pigs on other treatment combinations. No evidence for differences ($P > 0.10$) between treatments or interactions were observed for hot carcass weight or carcass yield. However, pigs weaned from sows fed the Oceanfeed Swine diet had greater ($P = 0.020$) loin depth than pigs weaned from sows fed control diet (Table 10).

In summary, the addition of Oceanfeed Swine in gestation, lactation, nursery, and finishing phases had no consistent effect on performance of sows or their offspring. However, a shift in the microbiota was observed in the pigs from sows fed Oceanfeed Swine diet, then fed Oceanfeed Swine, with higher number of species detected within Ruminococcaceae and Lachnospiraceae families that are generally considered beneficial, and lower number of species within the family Fusobacteriaceae that are normally considered pathogenic.

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Table 2. Composition of gestation and lactation diets (as-fed basis)¹

Item	Gestation ²	Lactation ³
Ingredient, %		
Corn	80.40	63.37
Soybean meal, 47% crude protein	15.61	29.99
Choice white grease	---	2.50
Calcium carbonate	1.15	1.05
Monocalcium phosphate, 21.5% P	1.40	1.30
Sodium chloride	0.50	0.50
L-Lysine HCl	---	0.20
DL-Methionine	---	0.05
L-Threonine	0.03	0.10
L-Valine	---	0.03
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
Sow add pack	0.50	0.50
Phytase ⁴	0.02	0.02
Oceanfeed Swine ⁵	---	+/-
Total	100.0	100.0

continued

Table 2. Composition of gestation and lactation diets (as-fed basis)¹

Item	Gestation ²	Lactation ³
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	0.56	1.08
Isoleucine:lysine	86	67
Leucine: lysine	209	139
Methionine:lysine	38	30
Methionine and cysteine:lysine	76	56
Threonine:lysine	79	67
Tryptophan:lysine	24	20
Valine:lysine	99	76
Total lysine, %	0.66	1.20
Metabolizable energy, kcal/lb	1,472	1,524
Net energy, kcal/lb	1,123	1,139
SID lysine:NE, g/Mcal	2.26	4.24
Crude protein, %	14.1	19.8
Calcium, %	0.91	0.90
STTD ⁶ P, %	0.47	0.49

¹Gestation diets were fed from d 30 to d 112 of gestation and lactation diets were fed from day 112 of gestation until weaning. Diets were fed in meal form.

²Treatments were top dressed in a common gestation diet. In the control diet, the top dress contained ground corn. In the treatment diet, the top dress contained ground corn and Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) was added to equal a 0.5% of the total diet.

³During lactation, Oceanfeed Swine was added at 0.66% of the diet.

⁴HiPhos 2700 (DSM Nutritional Products, Inc., Parsippany, NJ) provided 184 FTU/lb and an estimated release of 0.10% available P.

⁵Oceanfeed Swine is produced by drying and blending a selected mix of brown, red, and green seaweeds.

⁶STTD = standardized total tract digestible.

Table 3. Composition of nursery diets (as-fed basis)¹

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredient, %				
Corn	47.08	56.97	63.21	67.48
Soybean meal, 47% crude protein	18.83	29.05	32.94	29.19
Whey powder	20.00	10.00	---	---
Enzymatically treated soybean meal ³	5.00	---	---	---
Fish meal	4.50	---	---	---
Choice white grease	1.50	---	---	---
Calcium carbonate	0.55	0.90	1.00	0.90
Monocalcium phosphate, 21.5% P	0.40	1.00	1.00	0.90
Sodium chloride	0.30	0.55	0.60	0.50
L-Lysine-HCl	0.40	0.50	0.40	0.33
DL-Methionine	0.19	0.20	0.15	0.10
L-Threonine	0.16	0.19	0.15	0.11
L-Tryptophan	0.04	0.05	0.03	0.02
L-Valine	0.10	0.13	0.05	0.00
Vitamin premix	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15
Choline chloride 60%	0.04	---	---	---
Phytase ²	0.08	0.08	0.08	0.08
Zinc oxide	0.39	---	---	---
Vitamin E, 20,000 IU	0.05	---	---	---
Oceanfeed Swine ⁴	+/-	+/-	+/-	+/-
Total	100.00	100.00	100.00	100.00

continued

Table 3. Composition of nursery diets (as-fed basis)¹

Item	Phase 1	Phase 2	Phase 3	Phase 4
Calculated analysis				
Standardized ileal digestible (SID) amino acids, %				
Lysine	1.40	1.35	1.30	1.15
Isoleucine:lysine	58	55	59	62
Leucine:lysine	112	112	121	130
Methionine:lysine	36	35	34	32
Methionine and cysteine:lysine	56	56	56	56
Threonine:lysine	62	62	62	62
Tryptophan:lysine	19.2	19.7	19.5	19.4
Valine:lysine	69	68	68	68
Histidine:lysine	34	35	39	41
Total lysine, %	1.54	1.48	1.45	1.29
Metabolizable energy, kcal/lb	1.543	1.489	1.482	1.487
Net energy, kcal/lb	1.157	1.105	1.090	1.103
SID lysine:NE, g/Mcal	5.49	5.54	5.41	4.73
Crude protein, %	21.5	20.6	21.6	20.0
Calcium, %	0.75	0.76	0.75	0.68
STTD ⁵ P, %	0.56	0.53	0.48	0.45

¹Nursery diets were fed in four dietary phases: phase 1, from d 0 to 7 in pellet form; phase 2, from d 7 to 21 in meal form; phase 3, from d 21 to 42 in meal form; and phase 4 from d 42 to 56 in meal form.

²HiPhos 2700 (DSM Nutritional Products, Inc., Parsippany, NJ) provided 912 phytase units (FTU)/lb and an estimated release of 0.14% available P.

³HP 300, Hamlet Protein, Inc., Findlay, OH.

⁴Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) is produced by drying and blending a selected mix of brown, red, and green seaweeds.

⁵STTD = standardized total tract digestible.

+/- Inclusion rate of Oceanfeed Swine was 0.75% of the diet and it was added at the expense of corn.

Table 4. Composition of grow-finish diets (as-fed basis)¹

Item	Phase 5	Phase 6	Phase 7
Ingredients, %			
Corn	74.24	80.55	84.63
Soybean meal, 47% crude protein	23.02	16.89	13.15
Calcium carbonate	0.90	0.90	0.85
Monocalcium phosphate, 21.5% P	0.50	0.40	0.30
Sodium chloride	0.50	0.50	0.50
L-Lysine-HCL	0.33	0.33	0.25
DL-Methionine	0.08	0.05	0.00
L-Threonine	0.10	0.10	0.09
L-Tryptophan	0.02	0.02	0.02
Trace mineral premix	0.15	0.13	0.10
Vitamin premix	0.15	0.13	0.10
Phytase ²	0.02	0.02	0.02
Oceanfeed Swine ³	+/-	+/-	+/-
Total	100	100	100
Calculated analysis			
Standardized ileal digestible (SID) amino acids, %			
Lysine, %	1.00	0.85	0.70
Isoleucine:lysine	61	60	64
Methionine:lysine	33	32	29
Methionine and cysteine:lysine	58	58	59
Threonine:lysine	62	63	68
Tryptophan:lysine	18.9	18.8	19.2
Valine:lysine	68	68	74
Total lysine, %	1.12	0.96	0.80
Net energy, kcal/lb	1,126	1,144	1,156
SID Lysine:NE, ⁴ g/Mcal	4.03	3.37	2.75
Crude protein, %	17.5	15.1	13.6
Calcium, %	0.58	0.53	0.48
STTD ⁵ P, %	0.32	0.29	0.26

¹Diets were fed *ad libitum* in meal form from 79 to 306 lb.

²Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Inc, Parsippany, NJ) provided 181.8 phytase units (FYT) per lb of diet, with an assumed release of 0.10% available P.

³Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) is produced by drying and blending a selected mix of brown, red, and green seaweeds.

⁴NE = net energy.

⁵STTD = standardized total tract digestible.

+/- Oceanfeed Swine was added at the expense of corn at 0.75% of the diet in phase 5 and 0.50% in phases 6 and 7.

Table 5. Effect of added Oceanfeed Swine in gestation and lactation diets on sow and piglet performance until weaning¹

Item	Control	Oceanfeed Swine ²	SEM	Probability, <i>P</i> =
Number of observations, n	14	14		
Parity	1.21	1.29	0.997	0.999
Gestation length, d	116.1	115.9	0.238	0.530
Lactation length, d	19.8	20.0	0.289	0.364
Sow weights, lb				
Day 30 of gestation	454.5	454.7	12.24	0.975
Farrowing	527.1	523.0	19.21	0.839
Weaning	507.6	498.3	18.91	0.434
Lactation weight change	-19.5	-24.7	5.026	0.476
Number of pigs				
Total born	17.9	18.0	0.984	0.900
Stillborn	1.5	1.5	0.388	0.594
Mummies	0.7	0.6	0.315	0.874
Born alive	15.7	15.9	0.782	0.890
Day 2 litter size ³	15.4	15.4	0.467	0.912
Day 19 litter size	13.4	13.2	0.354	0.778
Prewaning mortality, ⁴ %	15.3	15.6	0.008	0.959
Average pig birth weight, lb	2.88	2.96	0.099	0.561
Day 2 pig weight, lb	3.07	3.14	0.108	0.580
Day 19 pig weight, lb	12.09	11.92	0.401	0.765
Day 2 litter weight, lb	47.9	48.9	2.436	0.708
Day 19 litter weight, lb	160.2	156.8	4.880	0.609
Colostrum yield, g ⁵	6,335	6,588	331.5	0.527

¹A total of 28 sows (DNA 241, DNA Genetics, Columbus, NE) and litters were used. Dietary treatments were fed to sows from d 30 of gestation until weaning on d 20 of lactation.

²The Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) was top dressed to gestation diets to achieve the equivalent of 0.5% of the diet. During lactation, Oceanfeed Swine was added at 0.66% of the diet.

³Cross-fostering was performed within treatments on day 2 to equalize litter size.

⁴Percent pre-wean mortality = mortality day 2 to weaning ÷ number on day 2.

⁵Colostrum yield was estimated by using the equation described by Theil (2017).

^{*}Variables analyzed using a binomial distribution.

Table 6. Effect of added Oceanfeed Swine in gestation and lactation diets on milk and colostrum profile¹

	Control	Oceanfeed Swine ²	SEM	<i>P</i> -value
Milk ³				
Total solids, %	19.40	19.79	0.405	0.464
Fat, %	8.66	8.83	0.373	0.727
Protein, %	5.00	4.88	0.129	0.501
Colostrum ⁴				
Total solids, %	27.27	26.00	0.855	0.308
Fat, %	6.13	5.41	0.420	0.235
Protein, %	15.42	15.67	0.708	0.804
IgG, mg/mL	5.46	5.12	0.143	0.114

¹A total of 28 sows (DNA 241, DNA Genetics, Columbus, NE) were used in the 100-d sow portion of the trial.

²In gestation, sows feed was top dressed with either ground corn or a combination of ground corn and Oceanfeed Swine™ (Ocean Harvest Technology, Galway, Ireland) to achieve the equivalent of 0.5% of the diet. During lactation, Oceanfeed Swine was added at 0.66% of the diet.

³Milk ejection was induced by a perivulvar administration of oxytocin on d 10.

⁴Approximately 30 mL of colostrum samples were collected during parturition and stored at -20°C until analysis.

Table 7. Interactive effects of Oceanfeed Swine in nursery pig dietary treatment on growth performance of nursery pigs¹

Sow treatment ² :	Control		Oceanfeed Swine		SEM	Probability, <i>P</i> =		
Nursery treatment ³ :	Control	Oceanfeed Swine	Control	Oceanfeed Swine		Sow × nursery treatment	Sow treatment	Nursery treatment
Weight, lb								
d 0	12.2	12.3	12.1	12.1	0.039	0.497	0.001	0.721
d 56	79.1	79.8	79.3	79.8	0.887	0.906	0.910	0.500
d 0 to 7								
ADG, ⁴ lb	0.26	0.24	0.21	0.23	0.017	0.286	0.060	0.955
ADFI, lb	0.34	0.30	0.29	0.31	0.017	0.153	0.316	0.444
F/G	1.35	1.27	1.64	1.34	0.111	0.324	0.117	0.086
d 7 to 21								
ADG, lb	0.74	0.73	0.71	0.72	0.019	0.678	0.431	0.922
ADFI, lb	1.01	1.07	1.00	1.05	0.025	0.854	0.552	0.055
F/G	1.36	1.49	1.41	1.48	0.037	0.522	0.586	0.009
d 21 to 42								
ADG, lb	1.35	1.36	1.39	1.38	0.023	0.657	0.276	0.971
ADFI, lb	2.08	2.08	2.11	2.12	0.036	0.809	0.363	0.956
F/G	1.54	1.53	1.52	1.54	0.015	0.363	0.838	0.853
d 42 to 56								
ADG, lb	1.86	1.90	1.88	1.91	0.030	0.885	0.608	0.229
ADFI, lb	3.43	3.45	3.38	3.50	0.056	0.343	0.918	0.219
F/G	1.85	1.82	1.80	1.84	0.024	0.173	0.503	0.868
d 0 to 56								
ADG, lb	1.19	1.20	1.19	1.19	0.017	0.815	0.797	0.707
ADFI, lb	1.93	1.94	1.91	1.94	0.029	0.706	0.681	0.418
F/G	1.62	1.62	1.61	1.64	0.013	0.286	0.896	0.244

¹A total of 360 pigs (DNA 241 × 600, Columbus, NE) with initial body weight of 12.2 lb were used in a 56-d trial with 5 pigs per pen and 18 replicates per treatment. Pigs were weaned at approximately 20 d of age and divided into light, medium, and heavy weight groups within sow treatment. Within each weight group pigs were allocated to either control or Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) dietary treatment in a split-plot design with sow treatment (control or Oceanfeed Swine) as the whole-plot and nursery pig treatment (control or Oceanfeed Swine) as the sub-plot.

²Sow treatment consisted of providing a control diet or a diet with Oceanfeed Swine to achieve the equivalent of 0.5% in gestation (d 30 to farrowing) and 0.66% in lactation (farrowing to weaning).

³Nursery treatment consisted of providing a control diet or a diet with Oceanfeed Swine at 0.75%.

⁴ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio.

Table 8. Main effects of sow and nursery diets supplemented with Oceanfeed Swine on nursery growth performance¹

Item	Sow treatment ²		SEM	P-Value	Nursery treatment ³		SEM	P-Value
	Control	Oceanfeed Swine			Control	Oceanfeed Swine		
Weight, lb								
d 0	12.3	12.1	1.74	0.001	12.19	12.21	1.74	0.721
d 56	79.4	79.5	5.24	0.910	79.2	79.8	5.24	0.500
d 0 to 7								
ADG, ⁴ lb	0.25	0.22	0.025	0.060	0.24	0.24	0.025	0.955
ADFI, lb	0.32	0.30	0.032	0.316	0.31	0.30	0.032	0.444
F/G	1.31	1.49	0.100	0.117	1.50	1.30	0.100	0.086
d 7 to 21								
ADG, lb	0.73	0.72	0.091	0.431	0.73	0.72	0.091	0.922
ADFI, lb	1.04	1.02	0.127	0.552	1.01	1.06	0.127	0.055
F/G	1.42	1.44	0.034	0.586	1.38	1.48	0.034	0.009
d 21 to 42								
ADG, lb	1.35	1.38	0.076	0.276	1.37	1.37	0.076	0.971
ADFI, lb	2.08	2.11	0.154	0.363	2.10	2.10	0.154	0.956
F/G	1.53	1.53	0.034	0.838	1.53	1.53	0.034	0.853
d 42 to 56								
ADG, lb	1.88	1.89	0.055	0.608	1.87	1.90	0.055	0.229
ADFI, lb	3.44	3.44	0.165	0.918	3.40	3.47	0.165	0.219
F/G	1.83	1.82	0.042	0.503	1.82	1.83	0.042	0.868
d 0 to 56								
ADG, lb	1.19	1.19	0.070	0.797	1.19	1.19	0.070	0.707
ADFI, lb	1.94	1.92	0.140	0.681	1.92	1.94	0.140	0.418
F/G	1.62	1.62	0.026	0.896	1.61	1.63	0.026	0.244

¹A total of 360 pigs (DNA 241 × 600, Columbus, NE) with initial body weight of 12.2 lb were used in a 56-d trial with 5 pigs per pen and 18 replicates per treatment. Pigs were weaned at approximately 20 d of age and divided into light, medium, and heavy weight groups within sow treatment. Within each weight group pigs were allocated to either control or Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) dietary treatment in a split-plot design with sow treatment (control or Oceanfeed Swine) as the whole-plot and nursery pig treatment (control or Oceanfeed Swine) as the sub-plot.

²Sow treatment consisted of providing a control diet or a diet with Oceanfeed Swine to achieve the equivalent of 0.5% in gestation (d 30 to farrowing) and 0.66% in lactation (farrowing to weaning).

³Nursery treatment consisted of providing a control diet or a diet with Oceanfeed Swine at 0.75%.

⁴ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio.

Table 9. Interactive effects of Oceanfeed Swine on growth performance of grow-finish pigs¹

Sow treatment ² :		Control		Oceanfeed Swine		Probability, <i>P</i> =			
Grow-finish treatment ³ :		Control	Oceanfeed Swine	Control	Oceanfeed Swine	SEM	Sow treatment × nursery treatment	Sow treatment	Finishing treatment
Weight, lb									
	d 0	79.0	79.8	79.2	79.8	2.743	0.962	0.981	0.813
	d 55	205.9	208.3	207.7	204.8	3.598	0.464	0.802	0.937
	d 100	306.0	308.2	307.9	305.5	3.662	0.535	0.916	0.976
d 0 to 55									
	ADG, ⁴ lb	2.31	2.34	2.33	2.27	0.037	0.118	0.425	0.530
	ADFI, lb	5.71	5.69	5.58	5.56	0.088	0.973	0.209	0.847
	F/G	2.47	2.43	2.39	2.45	0.031	0.061	0.245	0.661
d 55 to 100									
	ADG, lb	2.22	2.22	2.21	2.24	0.045	0.721	0.972	0.747
	ADFI, lb	7.39	7.25	7.25	7.34	0.104	0.267	0.817	0.831
	F/G	3.33	3.26	3.28	3.29	0.044	0.509	0.845	0.553
d 0 to 100									
	ADG, lb	2.27	2.29	2.28	2.25	0.020	0.314	0.525	0.806
	ADFI, lb	6.47	6.39	6.32	6.36	0.085	0.507	0.310	0.823
	F/G	2.85	2.80	2.78	2.82	0.032	0.132	0.484	0.919
Carcass data									
	HCW, lb	231.6	234.5	234.1	232.9	2.775	0.503	0.880	0.787
	Carcass yield, %	75.71	76.06	76.24	76.10	0.207	0.247	0.193	0.612
	Backfat depth, in	0.71	0.66	0.66	0.67	0.015	0.059	0.146	0.272
	Loin depth, in	2.51	2.54	2.59	2.57	0.023	0.270	0.020	0.647
	Lean, %	53.1	53.6	53.8	53.6	0.35	0.073	0.109	0.345

¹A total of 347 pigs (DNA 241 × 600, Columbus, NE) with initial body weight of 79.5 lb were used in a 100-d grow-finish trial. At the end of the nursery period, pigs from two nursery pens within weight block and treatment were combined and placed in each grow-finish pen with approximately 10 pigs per pen and 9 replicates per treatment.

²Sow treatment consisted of providing a control diet or Oceanfeed Swine™ (Ocean Harvest Technology, Galway, Ireland) to achieve the equivalent of 0.5% in gestation (d 30 to farrowing) and 0.66% in lactation (farrowing to weaning).

³Grow-finish treatment consisted of providing a control diet or a diet supplemented with Oceanfeed Swine at 0.75% and 0.50% for grower (75 to 130 lb) and finisher (130 to 280 lb) periods, respectively.

⁴ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio. HCW = hot carcass weight.

Table 10. Main effects of Oceanfeed Swine on growth performance of grow-finish pigs¹

Item	Sow treatment ²		SEM	P-Value	Nursery treatment ³		SEM	P-Value
	Control	Oceanfeed Swine			Control	Oceanfeed Swine		
Weight, lb								
d 0	79.4	79.5	2.47	0.981	79.1	79.8	2.474	0.813
d 55	207.2	206.2	3.25	0.802	206.8	206.6	3.247	0.937
d 100	307.1	306.7	3.30	0.916	306.9	306.8	3.304	0.976
d 0 to 55								
ADG, ⁴ lb	2.32	2.30	0.027	0.425	2.32	2.30	0.027	0.530
ADFI, lb	5.70	5.57	0.091	0.209	5.64	5.62	0.091	0.847
F/G	2.45	2.42	0.023	0.245	2.43	2.44	0.023	0.661
d 55 to 100								
ADG, lb	2.22	2.23	0.033	0.972	2.22	2.23	0.033	0.747
ADFI, lb	7.32	7.30	0.094	0.817	7.32	7.30	0.094	0.831
F/G	3.29	3.28	0.046	0.845	3.30	3.27	0.046	0.553
d 0 to 100								
ADG, lb	2.28	2.27	0.018	0.525	2.27	2.27	0.018	0.806
ADFI, lb	6.43	6.34	0.077	0.310	6.39	6.37	0.077	0.823
F/G	2.82	2.80	0.029	0.484	2.81	2.81	0.029	0.919
Carcass data								
HCW, lb	233.0	233.5	2.132	0.880	232.9	233.7	2.144	0.787
Carcass yield, %	75.89	76.17	0.188	0.193	75.97	76.08	0.190	0.612
Backfat depth, in	0.69	0.67	0.013	0.146	0.68	0.67	0.668	0.272
Loin depth, in	2.53	2.58	0.022	0.020	2.55	2.56	2.558	0.647
Lean, %	53.4	53.7	0.191	0.109	53.4	53.6	53.61	0.345

¹A total of 347 pigs (DNA 241 × 600, Columbus, NE) with initial body weight of 79.5 lb were used in a 100-d grow-finish trial. At the end of the nursery period, pigs from two nursery pens within weight block and treatment were combined and placed in each grow-finish pen with approximately 10 pigs per pen and 9 replicates per treatment.

²Sow treatment consisted of providing a control diet or Oceanfeed SwineTM (Ocean Harvest Technology, Galway, Ireland) to achieve the equivalent of 0.5% in gestation (d 30 to farrowing) and 0.66% in lactation (farrowing to weaning).

³Grow-finish treatment consisted of providing a control diet or a diet supplemented with Oceanfeed Swine at 0.75% and 0.50% for grower (75 to 130 lb) and finisher (130 to 280 lb) periods, respectively.

⁴ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio. HCW = hot carcass weight.

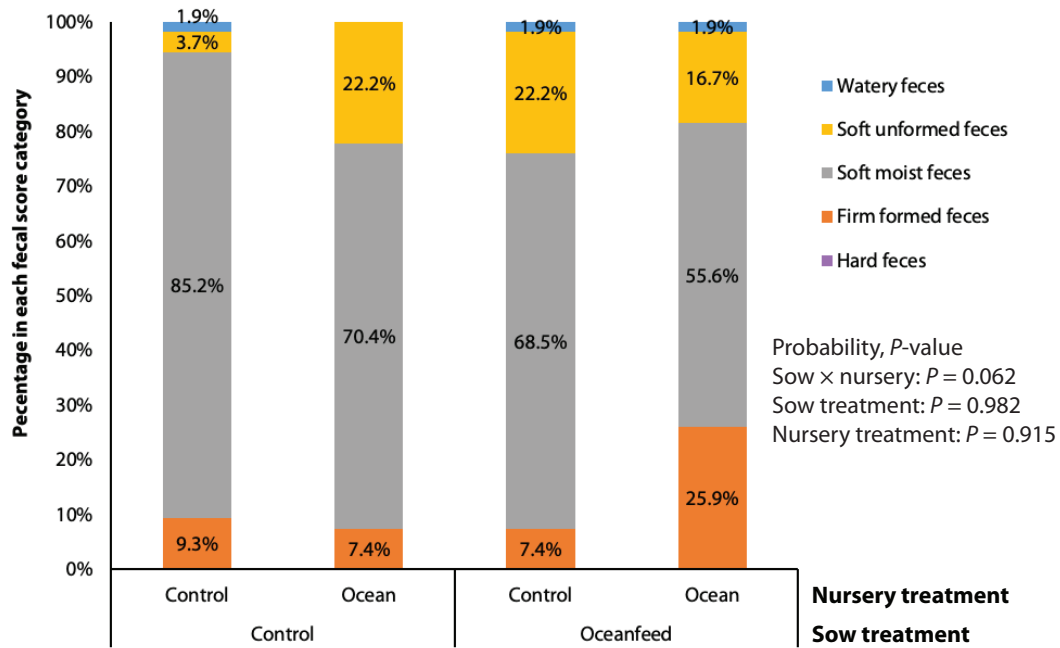


Figure 1. Frequency distribution of fecal score in nursery pigs by treatment.

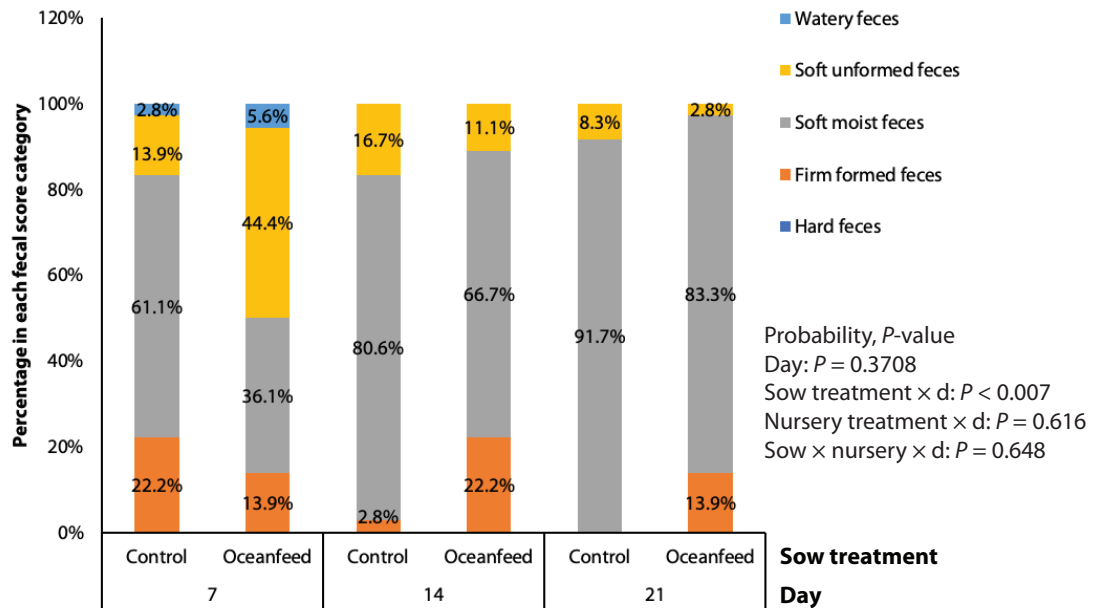


Figure 2. Frequency distribution of fecal score in nursery pigs by sow treatment by day.

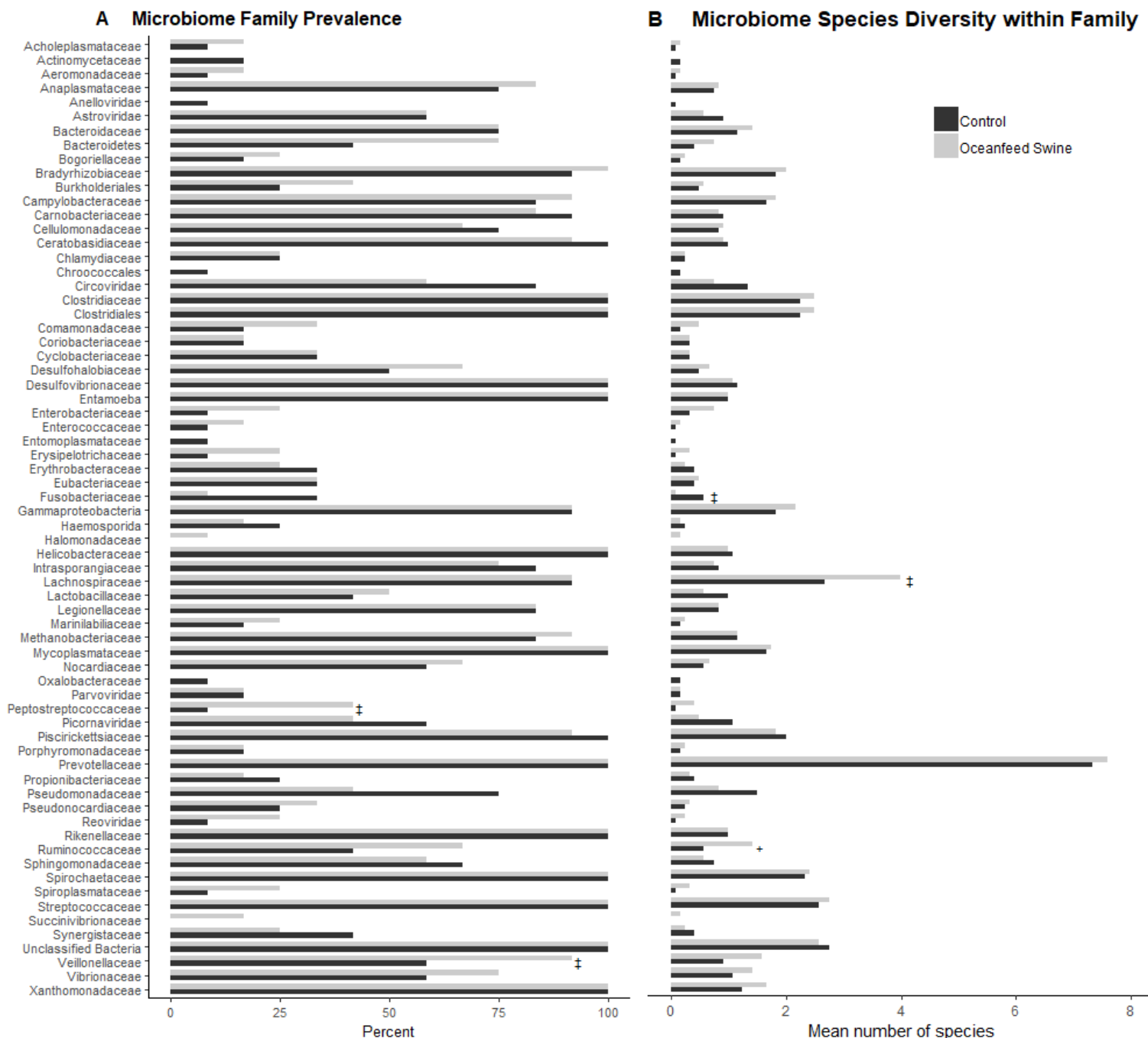


Figure 3. Fecal microbiome composition detected by the Lawrence Livermore Microbial Detection Array (LLMDA) from feces collected on day 56 in nursery pigs from sows fed control diets, then fed control and pigs from sows fed Oceanfeed Swine™ (Ocean Harvest Technology, Galway, Ireland) diets, then fed Oceanfeed Swine. (A) Microbiome family composition as a percentage of control pigs (n = 12) and Oceanfeed Swine pigs (n = 12) with that family detected. (B) Mean number of species detected in each group. ‡ Indicates $P < 0.10$. + Indicates $P < 0.05$.